

COMMONWEALTH OF PENNSYLVANIA.

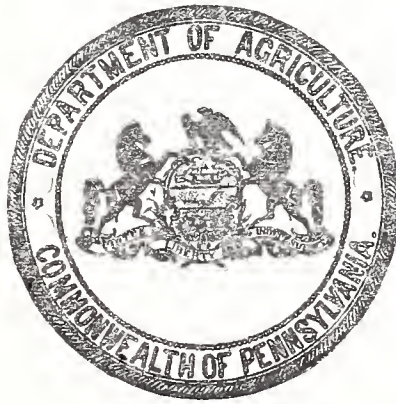
DEPARTMENT OF AGRICULTURE.

BULLETIN No. 129.

ALFALFA CULTURE IN HUMID LANDS,

BY

MR. JOSEPH E. WING,  
MECHANICSBURG, OHIO.



*PUBLISHED BY DIRECTION OF THE SECRETARY.*

---

1904.

---

WM. STANLEY RAY,  
STATE PRINTER OF PENNSYLVANIA,  
1904.



# TABLE OF CONTENTS.

---

	Page.
Preface, .....	5
Introduction, .....	7
History, .....	8
Alfalfa in the Eastern States, .....	11
Habits of growth, .....	11
Alfalfa bacteria and inoculation of soils, .....	16
Preparation of the soil, .....	19
Source of seed, .....	20
Amount of seed required, .....	21
Manner of sowing, .....	21
Alfalfa rust, .....	23
Mowing alfalfa meadows, .....	24
Fall care of new alfalfa meadows, .....	24
The second summer, .....	25
Making alfalfa hay, .....	26
Stacking out-doors, .....	28
Spontaneous combustion, .....	28
Covering alfalfa stocks, .....	29
Getting rid of grass and weeds; disking, .....	31
Need of water, .....	32
How to retain soil moisture, .....	34
Sub-irrigated land, .....	34
Irrigation in Pennsylvania, .....	35
Enemies of alfalfa, .....	37
Uses of alfalfa, .....	39
Food value of fodder crops, .....	40
Soiling, .....	41
General observations, .....	42
Experience in New Jersey, .....	44
Alfalfa as a pasture plant, .....	46
Danger from bloat, .....	47
Curing alfalfa bloat, .....	49
Grazing spring lambs on alfalfa, .....	50
Grazing pigs on alfalfa, .....	51
Alfalfa pasture for horses, .....	51
Alfalfa as bee-pasture, .....	52
Alfalfa in the sheep-fold, .....	54
Alfalfa for horses, .....	55
Alfalfa for swine, .....	56
Alfalfa for poultry, .....	57
Alfalfa for beef cattle, .....	58
Alfalfa silage, .....	58
Alfalfa as a soil-enricher, .....	60
Plowing alfalfa sod, .....	61
Rotation with alfalfa, .....	62
Alfalfa competition from elsewhere, .....	63



## PREFACE.

---

Harrisburg, Pa., September 1, 1904.

Among the many forage plants produced in the United States, the most popular in certain sections, especially in the arid regions of the West is alfalfa. Its peculiar adaptation to this section of the country is no doubt owing to the deep tap root it sends far below the surface of the earth, thereby securing for its support the moisture which is not available to many other plants. The attention of the writer was first directed to the value of this plant some years ago in the State of Washington, where he had the opportunity of seeing extensive acreages of alfalfa upon which large herds of swine were grazing and apparently doing as well as though fed upon grain. Later, it was his privilege to see many herds of range cattle in the State of Colorado fed upon alfalfa hay with equally good results. Within the last year the Pennsylvania State Live Stock Sanitary Board has tested the excellent feeding properties of alfalfa hay at the Experiment Farm in Delaware county. These observations led the writer to invite correspondence with farmers of this State who have had any experience in producing this plant, and although the result of such correspondence shows that comparatively few farmers have tried to raise alfalfa, enough has been done to prove that with proper care it may be grown in every section of the State. Some of the letters received at this Department show that it is being produced at the highest altitudes in the mountainous sections, where the soil is a light gravelly loam, while others show that it may be successfully grown in the limestone clay soil found in many of the valleys of the State.

Prompted by the belief in the possibility of making alfalfa a paying crop in Pennsylvania, correspondence was opened with Mr. Jos. E. Wing, of Mechanicsburg, Ohio, who is one of the most extensive producers of alfalfa in the Eastern or Middle States, and arrangements were made with him for the preparation of the following bulletin, which is now sent out in the hope that it may prove a lasting benefit to the agriculture of the State.

N. B. CRITCHFIELD,  
Secretary of Agriculture.



# ALFALFA.

BY MR. JOSEPH E. WING, *Mechanicsburg, Ohio.*

---

## INTRODUCTION.

Much has been written of alfalfa growing in arid regions, dependent upon irrigation, and in the dryer part of the United States, west of the Missouri River. It has been assumed that alfalfa would not thrive far east of the Missouri, or that if it did thrive, similar conditions of culture should be given to those that succeed in the West.

Hardly any other plant has been so much exploited as the alfalfa plant. Hardly any plant has been so generally disappointing to the inexperienced experimenter. There is a steady sale of seed throughout the Eastern states, and of this seed, it is safe to say, that 80 per cent. of it is wasted. Most men fail when they attempt to grow alfalfa. Many Eastern Experiment Stations have become discouraged by their efforts to grow the plant profitably.

The truth is that alfalfa has not been over-praised; nor need it have failed in many instances where sown in Eastern states. It will grow anywhere in the United States below elevations of 7,000 feet and profitably anywhere where its needs are considered. The difficulty has been that its culture has been attempted by men who were ignorant of the conditions needed to make it grow. It is not a crop like any other. The difficulties in the way of growing it are not hard to overcome. The hardest thing to overcome is the reluctance of men to give it attention, to devote to it suitable soil, and the slight attention that it needs thereafter to make it succeed. Pennsylvania farmers are proverbially careful and painstaking. It is certain that when alfalfa culture is well understood and its benefits realized, no Eastern state will rival Pennsylvania in its production.

There is no plant that can bring greater blessings with it than alfalfa. It robes the earth with beauty. It feeds the bees. It yields great amount of hay, and the hay is the richest known. It is planted but once for a long term of years. It enriches the soil on which it grows and the adjoining fields if the hay is fed on the farm and the manure put back. A farm well set in alfalfa is doubled in productive value.



## HISTORY.

Alfalfa is known in England and most of Europe as lucerne. It is not new. The Romans learned its use, probably from the Persians, and grew it to feed their chariot horses and war horses. Columella Virgil gives good instructions for growing alfalfa; the slaves piled the land up in raised beds, enriched it, sowed the seed, harrowed it in. These instructions, written so long ago, are mostly good practice to-day. Speaking of alfalfa, this old Roman says, "is the choicest because when it is sown it lasts ten years. It can be cut down four times, also six times, in a year, because it dungs the land. All emaciated cattle whatsoever grow fat with it because it is a remedy for sick cattle." After giving cultural directions, including deep plowing in October, a second plowing in February and careful preparation of the soil, with subsequent weeding and watering, he tells of feeding it: "Afterward, you are at liberty to cut it down as tender and young as you please after it has sprung up and give it to horses, but at first you must give it to them more sparingly until they be accustomed to it lest the novelty of the fodder be hurtful to them, for it blows them and creates much blood. Water it very often after you have cut it. When cultivated in this manner, it may be cut down six times in a year and it will last ten years."

Thus we see that alfalfa was well understood by these old agriculturists and was probably long cultivated before red clover was grown at all. Later on we find it a common forage plant in France, Germany and somewhat grown in England. Spain, too, found alfalfa a treasure and early introduced it into the New World. Without prejudice to the Spanish people, it is safe to say, that this gift of alfalfa is the best thing Spain has given to the New World. There are old Spanish fields of alfalfa in Texas, New Mexico and California, some of them dating back a century or more.

## ALFALFA IN THE EASTERN STATES.

Curiously enough, lucerne growing (as alfalfa was first called) was not uncommon many years ago in New York, parts of New England, Pennsylvania (probably) and Virginia. A century ago there were enthusiastic advocates of alfalfa culture; yet they encountered surprising conditions and difficulties. In some fields, growth was magnificent; in others, sickly and poor. Livingstone experimented with fertilizing alfalfa fields and it was learned that wood ashes had a most beneficial effect upon its growth. It is probable that without knowing it, farmers were troubled then as now with acid soils. It was thought that alfalfa culture would spread and revolutionize agriculture. It did not do so, for two principal reasons:



The uncertainty of its behavior in different sections, and the difficulty of growing seed. It was found to be almost impossible to produce seed, and reliance had to be made on imported seed. This was often bad. It was often from a land with a climate totally unlike ours and the plants were not hardy. Then our farming deteriorated, farmers became more careless, labor became dearer, the West was opened up and farm crops decreased in price, so that at last the matter was dropped and forgotten; yet there are old men in Virginia to-day who tell me that, when boys, their daily task was to mow a portion of lucerne and feed it green to the family cows.\*

There need not have been the abandonment of this crop; but the subject of alfalfa culture was not well understood, and the causes of success and failure were alike obscure. There seemed some magic about the plant. Its behavior could never be safely predicted. There was magic, of the sort not dreamed of, then. The growth of bacterial organisms was not understood, the interdependence of legumes and bacteria was not dreamed of and the conditions of soil necessary for the growth of bacteria was not, of course, thought of. Much that was mysterious had been observed in the behavior of the red clover plant. It thrived on new land; it enriched the soil; it was benefited strangely by applications of gypsum plaster and it refused to grow, and the land was termed "clover sick." The key to unlock all this was yet to be found, and was not until the study of the clover bacteria had laid bare a new world of facts, the most vital to the farmer of any that had been discovered.

---

\*The following notes on the early history of alfalfa in New York, by Hon. F. E. Dawley, are of value and interest:

"From 1791 to 1800, Mr. Robert Livingstone, of Jefferson county, New York, conducted some experiments, many of which were successful, and from investigations made in the vicinity of LeRaysville, in that county, I feel certain that there are still growing wild there alfalfa plants which are descended from his original plantings. Following these experiments, the next that I am able to get any authentic record of are those made about 1812 in Onondago county by Sterling Lamson and Moses Dewitt, and in Jefferson county by Ezra L'Hommedieu. About four miles west of Cedarvale, in this county, a few scattered plants have been growing for years on a side-hill, which I believe came from the seeding made by Mr. Lamson, as I can get no record of its having been planted in that vicinity until within the past ten years, and these scattering plants have been known there for at least forty years. In a diary kept by this man in 1815, the statement is made about alfalfa, that it grew so coarse that the animals would not eat it dry and that it was very dangerous in pastures because of producing bloat. In 1851 a cask of alfalfa seed was distributed among members of the American Institute and many patches were grown in New York, New Jersey and Connecticut.

In 1865, in this section, there was great interest in bee-keeping. A man by the name of Rosenkranz traveled all over the country selling rights for using the Langstroth bee hive and giving instruction in bee-keeping. He had traveled extensively on the Pacific coast and had become greatly interested in alfalfa as a bee-food. Among the bee-keepers in this section who were induced to try alfalfa were my father, Wm. Dawley, James Patterson, Charles Phillips, William A. House, who lived on the farm which I now own, and many others. In the western part of the state those who tried alfalfa were not very successful, although Mr. Phillips had a remarkably good stand at one time. I believe that all of them sowed it too thinly and that the proper bacteria were not present in sufficient quantities to make it a success. One of these experimenters sent to California for a bag of seed, which was shipped to him in the hull, being very dusty and foul. From this lot of seed, however, sent about 1870, on the farm which I now own, can be traced, I think, the origin of successful alfalfa growing here.

A little later than this, Dr. E. Lewis Sturtevant, who had charge of the State Experiment Station at Geneva and was very much interested in alfalfa growing, recommended its planting quite largely and many fields were put out. The failures in this State outnumber the successes greatly; still in the townships of Onondago, Dewitt, Geddes and Manlius, Onondago county, and Sullivan in Madison county, there are to be found many acres of very successful growth, and on high lands in these counties four-fifths of all the hay cut last year was alfalfa.

California gave us alfalfa. The "49'ers" found alfalfa fields cultivated in some irrigated valleys. Only a few men gave heed, and not for more than twenty years was there any decided turning to alfalfa by the newcomers. In 1873, Henry Miller, a butcher, of San Francisco, imported alfalfa seed from Chili. He sowed it in the San Joaquin Valley, where he was making a ranch to fatten cattle. It thrived. He sowed more, and yet more. This was, perhaps, the first object lesson of the great worth of alfalfa, of the fortune that it would bring, sown in a large way. A few years ago the firm of Miller & Lux owned more than a million acres of rich land. They grazed more than 100,000 head of cattle and numberless sheep on alfalfa pasture and fed them in winter on alfalfa hay. This, principally was won by the enterprise of alfalfa roots. There are other great alfalfa ranches in California, each year their owners growing richer, and the soil too.

From California the seed was taken to Utah, from Utah to Colorado, from Colorado to Kansas, while there were longer jumps farther eastward. In 1886, the first alfalfa was sown on Woodland Farm, in Central Ohio, the seed coming from Utah. About this time alfalfa culture was revived in New York and succeeding finely on the limestone land of Onondaga county, where it has assumed great importance. Many travelers have come east from Colorado and California, and enthused by what they have seen there, have attempted alfalfa culture under eastern conditions. They have failed nine times out of ten, and they do not know why. They might have succeeded nine times out of ten. It is the purpose of this bulletin to help the nine.

Alfalfa belongs to the great family of plants called Leguminosæ. It is a large family, with more than 6,500 species. In it are the peas, beans, locusts, all the clovers, vetches and alfalfas. The botanical name of alfalfa is *Medicago Sativa*. There are a number of varieties of alfalfa, some named and some not. The Turkestan alfalfa comes from Russian Turkestan. This is a cold, dry climate and Turkestan alfalfa is quite hardy. It is not, however, quite so vigorous a grower as the common alfalfa; it is, perhaps, more subject to leaf rust. Except in very cold mountain sections, it is not worth while making special effort to obtain Turkestan alfalfa seed in Pennsylvania. There is a variety cultivated in Minnesota that has a peculiar history. Many years ago a German, named Grimm, brought with him to that State, seed from his own home, though it had originally come from Sweden. He and his neighbors grew it successfully for above twenty years in that trying climate before any public attention had been called to it. It is of a ranker growth in northern latitudes than ordinary alfalfa and endures all temperatures. The seed is not at present on the market. There is a

wide degree of difference in the hardiness of alfalfa grown from seed raised in northern localities or southern. The Nebraska Experiment Station showed that alfalfa from Peru made an astonishingly vigorous growth, but was nearly all destroyed by winter. Seed from California was only, in part, hardy. Seed from Arizona was not much better. Utah, Colorado, Kansas and Nebraska seed proved all right. Alfalfa is like corn, it readily adapts itself to a climate and in a few generations gains hardiness, if it needs it, by



ALFALFA PLANT FIRST YEAR.

therefore, the two are not well sown together. It is readily choked by weeds and grass during its first summer. After the first year the plants become very vigorous and firmly rooted. It increases in vigor for two more years, perhaps longer, on very deep and fertile soils. The roots penetrate as deep as there is soil. There is no known limit to this. Alfalfa roots have been traced to a depth of more than thirty feet and there are well authenticated instances

the survival of the hardiest, or if sown in a warm climate, it loses its hardiness and becomes tender. For Pennsylvania conditions, seed should come from Nebraska or the Dakotas. It is not worth while to grow seed at home, for only in dry seasons will it mature seed; even Kansas and Nebraska are often too moist to make alfalfa seed. When it is desired to try to produce seed, the second or third cutting is saved and it is threshed like clover. Alfalfa should never be permitted to make seed until the roots are strong, for seed bearing weakens its vitality greatly.

#### HABIT OF GROWTH.

Alfalfa, like many good things, is not of strong growth when young. Red clover is more vigorous;



where they have gone far beyond that. It branches and fills the entire soil with feeding roots; therefore, it uses all the soil there is



TWO-YEAR ALFALFA ROOT.

in the field, be it little or more. Alfalfa roots will not run far into barren clay nor ever into saturated soils. Practically, in Pennsylvania soils, the feeding roots will seldom go more than thirty-six to forty eight inches, except in alluvial valleys, where they may feed down to a dept of ten to twelve feet.

Failure with alfalfa will result when rock or hardpan comes closer than about thirty inches to the surface. Also, if the water table or water level in the soil is not down at least thirty inches, it is not worth while sowing alfalfa on that soil. There is a thought here. We should drain our fields deep; no tile drains should go in to a less depth than forty-eight inches wherever the subsoil is pervious and the outlet can be secured. If alfalfa will use the soil to twice the depth that other

crops will, it is practically doubling the area of your cultivable land.

Alluvial soils, along rivers or creeks, with a porous, permeable subsoil produce, naturally, the best alfalfa; that is because they are rich in plant food, and mainly it is because they allow the air to circulate more freely throughout their depths than ordinary soils. Air is essential to the life of alfalfa roots. They will not live in a tight, saturated soil; we will see the reason why later on. Yet very stiff clays may be made to grow first-class alfalfa by a suitable preparation and then may maintain their productiveness for many years thereafter. On Woodland Farm, in the clays of Ohio, the best growths of alfalfa are secured on very stiff, heavy clays. Originally, these soils would not have grown this crop at all; they were first heavily manured with stable manure which,

when incorporated with the clay, loosened it up materially and encouraged the growth therein of earth worms. Tiles had been laid, the earth worms burrowing and the tiles together made these clays into clay loams and the growth of alfalfa was satisfactory from the first. After being plowed and corn grown on the land and then again sown to alfalfa, the growth is much more vigorous than at first, owing, no doubt, to the decay of the old alfalfa roots, letting in yet more air, and owing in part to the very efficient inoculation of the soil with the right alfalfa bacteria. It is worthy of note here that the corn grown upon that alfalfa sod was very much heavier than had even been seen upon this ground before. We will see the reason for this wonderful enriching of this soil later on.

There are in Pennsylvania many thousands of acres of clay loams, of limestone origin, that can be brought in a similar manner into alfalfa production. The obstacle to doing this is, that men will not usually devote to the crop rich land, having tiled and manured a field as it should be for alfalfa they can not bring their minds to consent to devote it to that crop, but think another, as corn or potatoes, will be more profitable. One need not sow alfalfa at all; but when he does he will waste his efforts if he does not put it upon well-drained and well-enriched land.

There is a singular fact in this connection. Soils naturally rich will not produce as good alfalfa, sown in the raw state, as older and more worn soils that have been well-manured. Alfalfa here does not behave in this respect as corn and some other crops which revel in new land and cannot be made to produce so well in old land by any system of manuring. One can take an old clay field and by heavy manuring with rather bulky manure plowed under, first having tiled it wherever needed, and sow thereon alfalfa, that will produce very heavy crops for a number of years; and then when it is plowed and planted to corn it will grow an astonishing crop, better than had the corn been planted on the freshly manured land instead of the alfalfa.

There is here a hint as to the great value of alfalfa. For four, five, possibly ten, years this good alfalfa field has yielded from four to eight tons of hay each year. This hay, fed to animals, the manure recovered, has enriched adjoining fields. At the end, the original field is found to be more productive than ever before. It is seen, therefore, that in a scheme for bringing a farm into a more productive state, alfalfa may come to the aid of the farmer in a most effective manner. It is, indeed, an enricher of soils, yet not of poor soils, except indirectly, for it will not grow upon poor soils.

A ready test of whether a soil will produce alfalfa, at least as to whether it is rich enough in humus and sufficiently drained to pro-

duce good alfalfa is to observe whether the blackbirds follow the plowman as he turns the soil. If they do, it is pretty certain that alfalfa will thrive there. If they do not, it is pretty certain that it will not. These birds follow the plow because of the earth worms that abound in soils well-filled with humus. They do not find earth worms in worn, cold, clammy soils.

Having gone thus far in advocating planting alfalfa on well-enriched soils, it may be well to show the reason why the crop is worthy such generous treatment. Once established, it fills the entire soil and subsoil with feeding roots. When spring comes it being already planted, it is a source of no farther expense. There is here a saving of several dollars on each acre. As soon as the sun shines and the ground warms a little, being already thoroughly established, it begins to grow, and it grows lustily. It is hardier to resist cold than red clover, and much more vigorous to start in the spring. Shortly after corn planting, it is from two to three feet high, and by the first of June, in the climate of Pennsylvania, it has matured the first crop. This date may be a little later in the mountain sections. There is thus one crop made by the time corn is starting to grow. Taking this crop off promptly, which is always right, and making it into hay, another springs up like magic. In thirty days from time of cutting the second crop is ready; in about forty days the third, delayed a little if the season is very dry, and in about forty-five days the fourth crop. After this there will be a considerable growth which may be allowed to stand to hold the snow and protect it in the winter. After corn is killed down by frost, alfalfa yet grows for some weeks. It thus uses all the soil and all the season and, as we will see later on, the result of this use is a product in some respects better than corn. Usually the crop from an acre of good alfalfa will buy the crop from two acres of corn. And there is always the satisfaction of feeling that the yield is not growing poorer, but richer instead, that erosion is stopped, that adjoining fields may share in the benefits from use of the manure coming from the alfalfa hay.

But supposing the soil to be both rich and well-drained, is it certain then to produce alfalfa? No. Alfalfa needs lime in the soil. Many soils, even when fairly rich are acid. Acid soils will not support the bacteria that enables alfalfa to grow. Lime is not, in itself, a fertilizer, but it enables alfalfa to grow and thus, indirectly, lime powerfully enriches the soil. Used with a grain crop and not followed with a legume, lime would set free fertility and impoverish the soil; used in connection with clover or alfalfa, lime makes soils good.

The farmer may himself easily test whether his soil is acid or



not. Litmus paper is the material prepared by chemists for making this test. Procuring it (the State Experiment Station will, no doubt, furnish it free to farmers needing it), take a small handful of soil suspected to be acid, choosing it from a depth of about five inches, place it in a clean dish or cup and add water with constant stirring until it is about as thick as paste. Take one end of a strip of litmus paper and push it into the soil, burying it for about half its length. Press the soil about the paper and allow it to stand for two minutes or longer. Take it out carefully, not to tear it, and wash the soil off with clean water. Now, if the soil is acid, the paper will have turned to a pinkish hue; if not acid, the paper will not have changed much except that it will be a little darker from being wet.

When acidity is found, wood ashes form the best corrective, though they are not available for large areas and fresh ground lime drilled into the soil is the best remedy. If this material is not available, it may be water-slaked, using only enough water to make it into a dry powder, and drilled in with a fertilizer drill. Or it may be sown broadcast after being water-slaked and harrowed in. Liming soils is not a new art in Pennsylvania, though the economical application of lime by means of drilling in fresh ground burned lime is new and deserving of wider use.

As to the amount to be used, no definite rule can be laid down. The better practice is to lime often and in smaller amounts than were once used. Fresh burned and ground lime may be drilled in at the rate of 500 pounds per acre, and in some soils this will prove sufficient. Often from 1,000 to 2,000 pounds per acre are applied when the lime is scattered broadcast over the ground and harrowed or turned in. The amount should be proportioned to the acidity of the soil.

There is a common weed on acid soils called sheep sorrel. Its presence is a pretty sure indication of acidity as it seems to thrive best in acid soils. Liming helps destroy it by making the conditions under which it grows less favorable. Where sorrel is growing it is hardly worth while sowing alfalfa until lime has been applied.

Very many of the failures to get a profitable growth of alfalfa are due to this acidity of the soil. When the soil is fairly fertile, if the plants have a yellow and sickly appearance, it is due to one of two causes, either the soil needs lime or inoculation and probably both. Of inoculation we will speak presently. There was some years ago a New Jersey alfalfa field most unthrifty and unprofitable though having a good, thick stand. The soil had been well enriched. One day, in passing through with a load of lime, the wagon broke down, and the lime was unloaded, and thrown upon the



ground. It was afterwards cleaned up again as clean as possible; yet the dust remained and there the alfalfa all at once shot up to ten times the height of the rest of the field and had a delightfully dark green, luxurious appearance. The hint was acted upon and the whole field lined with the result that it was all made good.

It is not generally believed that soils in limestone regions may need lime, yet it is often found to be true that above the limestone rock the clays may, through many centuries of leaching, have had their lime washed away so that they are as much benefited by applications of lime as any soils. In fertile England there are, on many farms, great pits whence chalk has been taken for centuries. This chalk is a soft rich lime and when exposed to the frost and air readily decomposes and sweetens the soil.

#### THE ALFALFA BACTERIA AND INOCULATION OF SOILS.

Most legumes and all clovers when growing naturally and healthfully are found to be associated with other microscopic forms of life, called bacteria. These bacteria are among the simplest and lowest forms of life known. There are thousands of kinds of bacteria some of them producing great mischief in the world, for bacteria cause dreadful diseases, such as consumption, typhoid fever and the like; but others are essential to agriculture and plant life. There is a singular interdependence in Nature; certain animals and plants seeming to live one for the other and to be unable to exist without the other. As an illustration, certain insects are necessary to the complete fertilization of certain flowers and without them no seed is produced. Thus, the red clover bloom depends for its fertilization almost altogether upon the bumble-bee and there are many flowers that depend upon one certain species of insect for the pollenization, while certain insects live exclusively upon one species of plant.

There is, too, in the economy of Nature, an interdependence of plants. There is, indeed, a natural rotation of plants that many observing farmers have seen. Grasses, so far as we know, are unable to gather nitrogen from the air and must, therefore, get it from the soil. Pastures and meadows, unless artificially enriched or unless fertilized by the decay of their own stems, deplete the soil after a time and produce less luxuriantly. The grasses get weak enough to give clovers a chance to fight for sun and air and root-hold, clovers, white and red, come in and the ground is, as we say "taken" by these clovers. Now, clovers live, in part, on nitrogen derived from the air, so they can thrive where grasses can not; they then develop a great luxuriance of growth and the grass is for the time a secondary matter. These clovers store the soil with

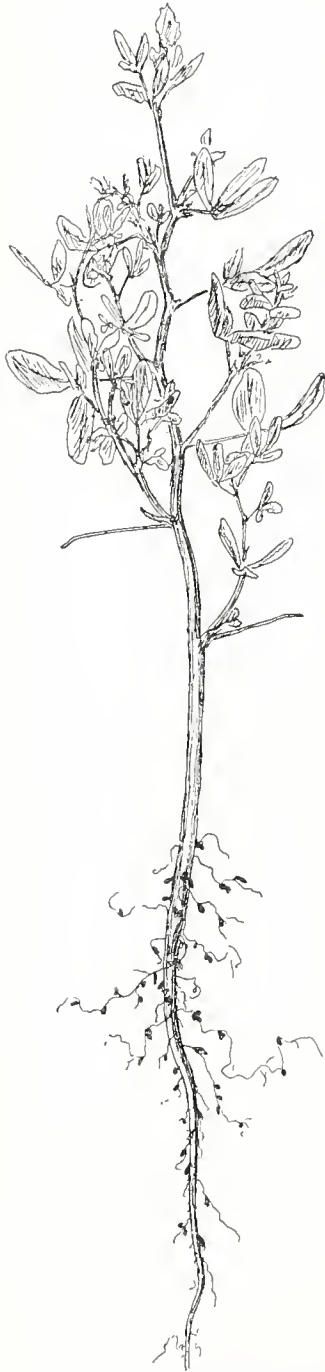
nitrogen, an element that most promotes growth of grass. The grass, then, starting early next spring, finds here such an abundance of suitable food that it grows rapidly and soon crowds the clovers into a secondary place. This luxuriance and predominance of the grasses continues until again the nitrogen is somewhat depleted and the soil less filled with grass when the clovers once more have their way. It is interesting to note that when mineral foods that clovers love, like potash and phosphorus, are added to the grass swards, there is at once a notable stimulation of the clover plants and, later, a great benefit to the grasses.

Now, bacteria are plants that thrive in moist, dark places and each species of clover seems to have its special variety of bacteria inhabiting its roots. Sometimes, indeed, these bacteria seem to inhabit two or more species of clover; but as a rule they do not. There is one form for alfalfa, one for red clover. It seems, from experiments made by Dr. Cyril George Hopkins, of the Illinois Agricultural Experiment Station, that the same bacteria inhabits both the sweet clover or melilotus and alfalfa, that where sweet clover grows naturally, as it does along roadsides and as a weed at the edges of the field, the soil will be found ready inoculated for alfalfa.

Just how these bacteria do their work we may never know. Attaching themselves to the small fibrous roots of the alfalfa, they induce it to grow out over them a fleshy excrescence called a tubercle or nodule. In these nodules the bacteria live. Just what they do, think and feel we don't know. In some mysterious way they appropriate nitrogen from the air found in the soil and give it up to the plant. There is a hint here why soils should be drained so that air can enter, should be loose for the same reason. These bacteria are very tiny; there would be a million or more in a large nodule. In examining clovers for nodules, one can never find them by forcibly pulling the roots from the soil; they must be taken up with great care as the attachment is slight and the nodules readily break loose from the hair-like rootlets.

Without the aid of the bacteria, alfalfa is a sickly, yellow, spindling plant, without beauty or profit. These bacteria are not found so far as we know, away from the plants that harbor them; that is, in a raw soil, where no alfalfa or sweet clover had ever grown within recent years one would hardly find any alfalfa bacteria unless, possibly, there might have blown dust from an alfalfa field or the manure applied might have had in it alfalfa particles to which bacteria adhered. Yet it is supposed that in threshing alfalfa seed more or less bacteria find attachment to the seed, so that when it is sown, nearly always a few of the seeds, more or

less, may be inoculated. Then if the conditions of dry, porous, sweet soil, with abundant vegetable matter within it are found, the bacteria increase with wonderful rapidity and presently the entire field is inoculated. In some soils this inoculation proceeds much more rapidly than in others. The practical difficulty in waiting for this natural infection is, that in the meantime the plants are small and sickly and the weeds growing vigorously make the fight a hard one for the alfalfa plants and they give up before aid reaches them.



ALFALFA PLANT THREE MONTHS OLD SHOWING ROOT NODULES ON THE FIBROUS ROOTS.

The Department of Agriculture, at Washington, has prepared a form of artificial inoculation that promises well, the seed being prepared before sowing. There is another scheme surer and not costly; to get soil from an old alfalfa field where it has grown rankly and there is, therefore, no doubt of its inoculation, dry this soil without applying heat, pulverize it and mix it with the seed at the time of sowing. It is not material how much earth is used, 50 or 100 pounds per acre would suffice, and more would do no harm, while less would serve but less efficiently, owing to the difficulty in distributing it. This earth should be harrowed in if this can be done; if not it is no great matter, as the rains will wash in the infection in any event.

Once a man has a small plot of inoculated alfalfa, if he uses the manure and spreads it over his fields, inoculation seems to proceed from this cause, or he can readily scatter earth from this field to newly sown fields. There is a practical gain in inoculation, for without it there is seldom any yield of hay the first season, while with it, if the season be moist, there is almost sure to be

a cutting in early September or late August of a ton or more per acre, so that there is a gain of eight to ten dollars per acre for the trouble of inoculation.

It is a curious fact that sweet clover, which harbors the alfalfa



bacteria, thrives in soils almost destitute of humus, while alfalfa revels in soils having a good deal of decaying matter within it. Western alfalfa acts much as sweet clover does here, and the writer has grown from eight to ten tons per acre on land that to the eye seemed almost barren sand and gravel. It had great depth; a well twenty feet deep showed no change in composition and the alfalfa had copious floods of water from irrigating ditches after each cutting. However, in eastern soils alfalfa must have more or less humus or decaying vegetable matter and more or less free nitrogen in the soil besides what it gets from the air through its bacteria.

Alfalfa will feed on free-nitrogen in the soil and relishes it, in fact finds it necessary to have a certain amount; yet it is not economy to grow alfalfa without inoculation, even were it possible, for when it is inoculated, Dr. Hopkins has shown, that the crop of about five tons per acre for the year (by no means a great yield) would fix from the air about 160 pounds of atmospheric nitrogen, equal to 195 pounds of ammonia. This may be in large part recovered in the manure and put back on the farm, enriching another field, and as nitrogen is worth from 9 to 12½ cents per pound in commercial fertilizers it is readily seen what a source of fertility alfalfa really is.

There is a new truth being understood about soils, that is that their productiveness is in direct proportion to their bacterial life. Investigation proves that fertile soils teem with bacteria, while barren ones are lifeless. The old saying of rich soils that they had "life," and of others that they were "dead," was accurate beyond what the scientists dreamed at that time. Bacterial life exists in proportion to the amount of vegetable matter and moisture and air in the soil. Waterlogged soils support no helpful bacteria. Acid soils support no bacteria helpful to legumes. These are small things to concern ourselves with, yet from these small things proceed mighty results. By knowing these things and working in harmony with them the farmer makes himself partner with the Almighty. The result of that partnership is not uncertain.

#### PREPARATION OF THE SOIL.

One should begin a year in advance to prepare for alfalfa sowing, the first step being to underdrain the field if it is wet in wet seasons or "spouty" in spring. Tile drains readily cure this condition, and whenever practicable they should be laid four feet deep, though one must take into account the nature of his subsoil, which may be so tenacious that a tile laid so deep would not "draw" and the surface would remain wet. However, this condition is readily remedied by heavy applications of any sort of bulky manure which

should be turned under and in its decay and in the earth worms that it harbors there will soon result in a porous condition of the soil. No rule for laying tiles can be made that will be of universal application; they may need to be as close as two rods apart and they may be laid at much wider intervals with equal effect on looser soils. In any case the outlets should be open so that all the water readily drains away and there should never be an opening where surface water may drain directly into the tile, else earth will wash in there and stop the drain.

A heavy coat of manure should next be put on and turned under, plowing a little deeper than is usual on that field and the field planted to corn, potatoes or tobacco. Whatever the crop, keep it clean, especially of foxtail grass or pigeon grass, the worst enemy of young alfalfa next year. Let no weeds mature seed in that field. If a winter cover crop is desired it may be of rye or hairy vetch, but either one must be turned under early next spring, preferably in early April. The hairy vetch, where it succeeds, is an admirable catch crop to sow after corn, sown at the last cultivation; it makes a vigorous fall growth and holds from leaching much available fertility besides stopping the erosion of winter. Being a legume, it is also a nitrogen-gatherer when properly inoculated.

When the land is ready to plow in the spring, put in teams enough to turn it deeper than ever it was turned before. If two inches of new soil is turned up, all the better, supposing the previous manuring to have been heavy enough. If the preceding crop showed that the soil was not yet very rich, more manure could, to advantage, be sown, spread over the land during winter and turned under. March plowing is good, and in warm, dry winters even earlier turning will be all the better as the soil will freeze mellow and settle down to a firm seed-bed without so much working.

The further preparation of the soil is exactly as one would give to fit for corn, several harrowings and working down to a firm, mellow seed-bed. Let this be finished after danger of hard freezes is over, say by the middle of April. As soon as it is in condition, at once sow the seed so that it gets an even start with the weeds.

#### SOURCE OF SEED.

All American grown seed seems to have good germinating power, but all is not of equal value to the Pennsylvania farmer. He should seek his seed in Montana, Nebraska or the Dakotas, though Kansas seed is apt to thrive with him. Imported seed may do well and may not, but is, as a rule, inferior to home grown. It is well to examine it for impurities, but, as a rule, alfalfa seed is very clean and free from injurious weeds. The exception is the alfalfa dodder but

it is not often found and it is quite doubtful if the farmer would be able to detect it in his seed. Alfalfa seed appears much like red clover seed, except that the grains are longer and slightly more kidney-shaped. There are three or more grades of the seed and only the best and plumpest should be chosen. Alfalfa seed is not usually expensive, ranging in price from 6 to 10 cents per pound, though failures in the Western crop have made it, temporarily, very dear. It is reasonable to suppose that the wet seasons will not continue in the West, and with dry seasons will again come plentiful supplies of seed.

#### AMOUNT OF SEED REQUIRED.

There are in a bushel of alfalfa seed about 14,448,000 individual seeds. Poor seeds runs to a higher number, but of less vitality. There are in an acre of land 43,560 square feet. To sow a bushel of seed to the acre would put 332 seeds to the square foot. To sow half a bushel, as is generally advised, would put 166 seeds to the square foot, and to sow 15 pounds, or one peck, would put on 83 seeds, or more than one seed to each two square inches. Seven and a half pounds to the acre will put on  $41\frac{1}{2}$  seeds to the square foot. Twelve to 16 plants to the square foot, at the beginning, are ample and they will not all live to maturity. It is evident then that men who advocate sowing as much as 30 pounds per acre have not actually tried this or have used poor seed or have sown under such bad conditions that their seed has, in part, been wasted. Good seed beds and good seed make better stands than excessive amounts of seed. Our practice on Woodland Farm has been to sow from 7 to 12 pounds per acre. We can see no difference in the thickness of the stand between these amounts. It seems to be natural for alfalfa to stand from four to six inches apart and efforts to crowd it to thicker growth are futile. It may be said that thick sowings discourage weeds, but the alfalfa plants are themselves weeds and result in feebler growth and consequent lessened vitality which is seriously felt during the first winter. Should the seed be of inferior vitality or the seed-bed be rough and badly prepared, a surplus of seed is perhaps a benefit.

#### MANNER OF SOWING.

Spring sowing should always be with a nurse-crop in Pennsylvania. There seems to be but two crops that are admissible—oats and beardless spring barley. If oats are chosen, they must be drilled in very thinly, not more than three pecks to the acre, for on this well-enriched soil they will stool enormously and that



amount of seed will give too thick a stand before they are cut. The manner of sowing is to sow the alfalfa seed broadcast and drill the oats in, or sow them both broadcast and harrow them in, in either case covering the alfalfa about an inch or less. Really, the ideal way is to sow the alfalfa after the oats immediately behind the drill, and lightly brush in the seed, but this plan is not so good should the season turn off dry immediately after sowing so, that taking a series of years, it seems best to sow in front of the drill. We sow, on Woodland Farm, with a grass seeding attachment to our disk grain drill, but hand seeding is as good. One must avoid deep covering of the seed, yet in loose soils it will come through a surprising amount of earth, sometimes through one and one-half inches.

When beardless barley is the nurse-crop it may be sown a little thicker than oats, as much as four or five pecks to the acre may be sown as it is so much lighter in straw and less apt to stool and lodge. After sowing, if the earth is very dry and the weather threatens to be dry, the land should be rolled hard with a heavy roller. This firming of the seed-bed is essential in dry seasons, though judgment must be used as it will work injury in wet seasons to be so firmly compacted.

The question is very often asked: "Can I not sow alfalfa with winter wheat in the spring, as I would clover, or can I not harrow the alfalfa in and thus get a stand?" The writer has never seen an instance of success with this method, nor with sowing with rye, buckwheat or any other spring crop than oats and spring barley.

The object of the nurse-crop is not, as some believe, to keep the sun from plants. Alfalfa loves sun and rarely gets too much of that. The nurse-crop holds weeds in check and the alfalfa as well, to quite an extent, but when it is taken away it gives the ground to the alfalfa and it thrives better than had it been left to cope with vigorous annual weeds and grasses. Very often foxtail grass is so rank and persistent in alfalfa sown alone that despite repeated mowing, it chokes the alfalfa so that it perishes the first winter. Mowing will not kill foxtail grass, but rather thickens it.

The term "nurse-crop" is rather misleading and leads to wrong practices. The "nurse" indeed is too apt to rob the baby alfalfa and leave it to perish. Therefore, the sooner the nurse is taken away the better, after reaching near to maturity. Oats allowed to ripen over the alfalfa will usually crowd it out, and destroy enough of it to make the stand thin and weak. The reason of this is twofold; the shading of the alfalfa weakens it and the crowding of its roots by the more vigorous oat plants, and the later exhaustion of the soil water, finally weaken it to the point of destruction.



To save this evil result one should mow the oats close and make them into hay when coming into bloom. At this time the alfalfa will yet be strong, and the oats cut then, will make sweet and nutritious hay relished by all animals. Indeed, there is no way one can get greater profit from an oat crop than to cut it then, if he has market for such hay either to feed to his own animals or to sell.

The reader should heed this point carefully, as many attempts to grow alfalfa have resulted in failure, just from neglect to cut off the oats soon enough. Watch when the bloom appears on the earlier heads and the little stamens hang out, then make the crop promptly into hay and your alfalfa will not be checked. Care should be taken not to allow the hay cocks to remain long upon the ground or they will smother the alfalfa and leave bare spots in the field. The same is true of barley shocks when the field is sown to barley as a nurse-crop.

Making hay of oats cut thus green is rather slow business, but it can be done and on a large scale, as the writer knows from experience, for he has made hundreds of tons in that way and secured fine stands of alfalfa beneath it; but he has always noticed that where he first began cutting the oats there was a finer stand on that side than on the opposite where he finished cutting, perhaps ten days later.

Beardless spring barley is an excellent nurse-crop, as it has a short stiff straw and does not tiller very much, therefore, does not shade the alfalfa as oats are inclined to do. Coming off very early, it may usually be permitted to ripen its grain without serious injury to the alfalfa; in fact, the writer always allows his barley to ripen unless it should happen through wet or storm to lodge, when he makes it at once into hay, and green barley makes a most nutritious and palatable hay. In reaping the oats or barley, cut as close to the ground as possible. For this reason the land should be dragged smooth or rolled when the crop is sown. The reason for this is that alfalfa thrives to be cut; in truth, it is absolutely essential to success that it should be cut rather often.

#### ALFALFA RUST.

The enemy and frequent destroyer of alfalfa in the Eastern states is alfalfa rust. It does not much appear west of the Missouri River, but has been responsible for a vast amount of mischief in the more humid regions. Alfalfa rust appears upon the leaves after about thirty to forty days of growth. At first a slight yellowing is noted, beginning on the older leaves down the stem. This spreads to higher leaves till many of them are yellowed, and finally they drop off. Eventually there is a bare stem, with a few tufts

of leaves at its extremities. Then a new growth starts from the root, but not very vigorously.

Alfalfa rust is especially destructive the first season, as it prevents top growth; and without top growth there can be no root growth and, therefore, the plants do not get strong enough to go through the winter. Many times men have tried alfalfa, it has started well, they have been encouraged; then, upon going to see it they have found it yellowed and making no growth, and they have declared, "alfalfa is a failure here." It is, indeed, a failure if it does not have help. Fortunately, the remedy is easy. To cut it off close with a mower will at once stop the rust and the new shoots coming up in a day or two are vigorous. They, in turn, will rust in a few weeks, when they must, in turn, be cut off. Alfalfa has, indeed, been periodically cut for so many centuries that it will not survive neglect of this fundamental duty.

This entails some expense the first season, though, as a matter of fact, the weeds generally need cutting at the time that rust appears, but after the first year it is of little importance as, fortunately, the rust does not appear until it is time to make the crop into hay.

#### MOWING ALFALFA MEADOWS.

There is another thought here worth noting. In establishing alfalfa meadows, it often happens that after taking off one or two good crops, there is so little moisture in the land or some unexplainable thing has happened so that the alfalfa makes no great growth. It may, indeed, be so short as to seem hardly worth cutting. Should the farmer decide to let it stand, he will make a grave mistake, for there will be no improvement of the alfalfa until it has been cut. The writer has cut a second crop that made but one-half to three-quarters of a ton to the acre, cutting it at the right time, and had the field at once so improve that the next crop was very heavy, making one and one-half tons to the acre or more. The reason for this we do not know, but the fact is well-established. Furthermore, in fence corners and places where alfalfa is not regularly mown it soon becomes a thin stand and eventually only a few plants remain.

#### THE FALL CARE OF NEW ALFALFA MEADOWS.

Mowing should cease early enough to allow a growth of twelve inches or more to catch and hold the snow and protect the crowns. No animals should pasture on the alfalfa the first fall, nor should stock ever tread upon the alfalfa in winter or when the ground is wet and soft. If the land is very clayey and apt to heave out clover in the winter it may be wise to thinly spread stable manure on

the bad spots to prevent too much freezing and thawing. Heavy mulches of manure or anything else are destructive to alfalfa.

#### THE SECOND SUMMER.

Alfalfa starts early and is hardy; only very severe freezes affect it. If it is designed for grazing with hogs it should not be turned into until the ground is dry and the season of frosts has passed, as it destroys alfalfa stems to trample them when frost-covered. Nor is the very green, sappy alfalfa very nutritious or healthful food. About May 10, it is twelve to eighteen inches tall and then is the time to turn stock on it. There should be a division in the pasture so that only one side at a time will be grazed down.

The meadow should be closely observed by the novice in alfalfa culture so as to cut it at the right time. It will be seen just as it comes into bloom that the leaves are yellowing and dropping, leaving a bare stem. It should be cut immediately. If permitted to lose its leaves it is very greatly damaged. Some early growers of alfalfa in Ohio discarded it because of their experience that "it was such woody stuff that stock did not like it." When questioned as to the time of cutting, it was learned that it had been cut the first time in July, when it should have been cut by the first of June. There are two advantages in prompt cutting; the hay has twice the value and the second cutting comes on better and before the soil has become so dry. One can get four cuttings or two from an alfalfa field, the four will contain a half more pounds of hay and double the intrinsic value in nutrition.

It is, however, possible to cut too early. At the time of budding, alfalfa contains more water and slightly less protein than when in early flower; it is growing rapidly at this time and should be allowed a few days of growth. When alfalfa blooms appear the stalks constitute about 50 or 60 per cent. and the leaves 40 or 50 per cent. of the whole plant. As flowering progresses the leaves are lost and the stems become woody. Stems contain three or four times as much crude fibre as the leaves and leaves two or three times as much of the albuminoids. The constant aim should be to cut with all the leaves on the stems and to cure the hay to save the leaves. Experiments made by the Nebraska Experiment Station showed that alfalfa leaves fed to pigs in winter made the same gains that other pigs made, fed wheat middlings; they are somewhat richer in muscle-making, milk-making elements than wheat bran. One would consider a farmer criminally wasteful and foolish to strew his fields with wheat bran, yet that is what careless farmers do with alfalfa leaves and then wonder why they do not get the results that others have reported.



There is, however, a stage of cutting that may greatly damage the alfalfa for one succeeding crop at least. Before it has come to bloom, if it is cut, there sometimes appears a check in thrift and growth very marked and as yet unexplained. It probably affects injuriously the sap of the roots and perhaps the bacteria; the alfalfa recovers in time but one crop is practically lost. This result is not always seen and may be more common in wet seasons.

#### MAKING ALFALFA HAY.

Making alfalfa hay is not difficult except under very unfavorable conditions; yet there are certain differences between methods in making alfalfa hay and timothy or other hay which must be observed if the real good of the crop is to be had. When alfalfa is ready to cut one should have at his command tools and men enough to push the work. It may be mown at anytime, when dew is on or after the dew is off. It is not injurious to set the mower rather close to the ground. If the crop is very heavy it may be turned with the tedder, but care must be observed to stop the tedder before the leaves are dry enough to shake off. The writer uses the tedder very much less than he did in former years. When wilted and partly dry but before the leaves will fall, it should be raked into rather small windrows, and if conditions for drying remain good it may be allowed to dry yet a little more in these windrows. It should then be put into cocks with forks, the old-fashioned cocks, small at base, narrow and as tall as can be piled without danger of being blown down. In these cocks the hay is safe from showers, for being put up rather green the stems droop and shed rain well. It should be cocked before dry enough to scatter the leaves. Should there be hot weather with drying winds it will cure in a day or two in these cocks, though it is good practice to open them, throwing out in three or four flakes to the sun and air. These may be turned once, again piled into cocks and hauled to the barn.

In sending men to the field to do this work it is well to give each one personal instruction as to the manner of doing it, as laborers are not accustomed to handling a crop where they can do so much damage by wasteful and careless handling. Show them that the leaves which they may break off are worth as much pound for pound as wheat bran and their respect for the product will be much increased and their method more careful.

Alfalfa hay need not be bone-dry to keep in large masses. If the stems seem a bit tough when it comes from the cock it may yet be dry enough to keep perfectly. If a wisp of the hay, when twisted hard, shows moisture exuding it is too green and will damage in

the mow, but if no moisture can be twisted from it it will keep. If dried too dry there is the danger of losing a part of the leaves and the disadvantage of not being able to get as much in the mow as it should hold, for very dry hay will not pack together. When but a ton or two is put together in a small loft it must be quite dry or it will become musty. The large mow heats, cures by its own heat, and the heat no doubt destroys the germs of fungi so that the hay comes out uninjured.

When making large amount of alfalfa hay, one will often find that the rake will not get over the field as fast as it should on very drying days and presently the alfalfa begins to lose its leaves. The one remedy is to cease raking, let it lay untouched until after sunset in the evening, when, in a surprisingly short time, they will regain their toughness and the field may be raked with safety. The writer has had men raking hay until after dark and thereby saved all the leaves and many times the extra expense so incurred.

While the tedder is a tool to be used with caution in making alfalfa hay, the side-delivery hay rake comes in good play. With this tool the hay may be lifted and moved gently to one side, where it lays up loosely so that air penetrates it well; two or three swaths may be put together; it may be turned back and the green side put up and finally it may be put in cock or even loaded with the hay loader and put directly into the barn. There is always more danger of damaging the hay, either by putting away too green or by allowing it to get too dry when the hay loader is used, and care should be had in selecting a loader that elevates the hay with the least agitation, else many leaves will be lost.

There is a principle to be observed in making alfalfa hay that applies to making hay from all clovers. If it can be so managed that the leaves are not at once burned and dried to powder the moisture from the stems is the more easily removed. Leaves are natural evaporators of sap; stems are not. Therefore, while the leaf has yet pliancy and some semblance of its natural condition it is most efficiently carrying away the sap of the stem, but when it has dried up it no longer aids in drying the plant at all. Therefore, the best hay in all respects is made partly in the shade, in loosely turned windrows, in narrow cocks.

The difficulty in making alfalfa hay has been greatly exaggerated. The writer finds it easier made than red clover hay cut nearly as green. In making about 350 tons of alfalfa hay each summer there is, of course, hay out in nearly every rain during the summer; yet he can recall less than a dozen tons that were spoiled by rain and less than half of that that spoiled in the mow during six years.

## STACKING OUT-DOORS.

It is commonly taught that alfalfa can not be safely ricked out of doors. That this is a mistake, the experience of the writer abundantly proves, for for several years on Woodland Farm many large alfalfa ricks have been built and the amount of spoiled hay taken from them has been trifling. There are certain things to remember in stacking alfalfa. The foundation should be of good open work of poles or rails, high enough to allow air to circulate freely. We build the ricks about 16 feet wide and 30 to 50 feet long, and as high as possible, generally about 25 feet. They settle greatly and are topped twice. The hay for ricking is treated exactly as though it was intended for the barn, raked, cocked while tough, dried until no moisture can be wrung from it and immediately put in place. In truth, some experiences of stacking hay late in the fall, when the weather was not favorable for drying hay, indicate that alfalfa may be ricked greener than it can be put in the mow. However, it may be too green. One fall, when the fourth cutting was late in coming off, the weather was dull and showery so that the hay could not be dried. A large rick was built of it, only half cured. This rick heated to such an extent that part of it was charred, some was made into excellent silage and, with the exception of a very little mould, the rest was excellent brown hay. It is notable that stock likes better this brown hay than hay that is dried so that it cures with the green color. The fact is the great heat developed in curing under-dried hay partly cooks it; there is a loss in carbohydrates, but the hay is richer than ever in protein and no doubt more digestible. In the valleys of Nebraska where, from lack of labor, very crude methods prevail, there is much of this brown hay, which is generally termed "rotten" by the ranchers. They tell, with astonishment, that their animals eat this "rotten hay" better than the good; but it is a misuse of the term, for the hay is far from being rotten, and is much more nutritious and digestible than before it heated. Notwithstanding this fact, it is wise to dry the hay enough to make it retain its green color in part, for there is danger of leaving in it enough moisture to cause serious loss.

## SPONTANEOUS COMBUSTION.

This rick of silage and charred hay would have burned had we helped it by opening it and admitting air at the right time. By leaving it alone it died from smothering; there was not oxygen enough in the mass to make it burn. There are, however, a good many instances of spontaneous combustion occurring in alfalfa ricks and mows in Kansas where the very rank growths are often put up without sufficient drying. It is notable that in many in-



stances recorded the fire started after the farmer had become alarmed and tried to tear out the hot place, thus admitting air, which speedily set it going. The writer is inclined to believe that chances of spontaneous combustion in barn or rick from green alfalfa, if left alone, is not more than one in a million.

#### COVERING ALFALFA STACKS.

In the late fall a covering of quite green alfalfa may serve to keep it fairly well, but a much better covering is of wild hay laid on carefully to a depth of a foot or more. Dry alfalfa laid on the top will admit every drop of rain that falls. There are arrangements of chains that hold inch boards horizontally, overlapping each other as shingles overlap, that make very satisfactory roofs for stacks. In Pennsylvania, where alfalfa hay will readily sell for high prices, permanent barns and sheds will pay better than anything for sheltering alfalfa. Alfalfa hay may be baled and shipped. It should not be baled until it has been in the mow or stack long enough to have gone completely through its "sweat" and become thoroughly dry, and alfalfa bales should always be kept off the ground.

The alfalfa grower must forsake his dilatory ways and make of haymaking a serious and somewhat strenuous business. There is a rather short time in which all the alfalfa should be cut, as delay injures it more than other forage crops, especially in Eastern climates. The alfalfa, when it is cut, must be made promptly into hay and at once stored away or great loss will ensue. This means that plenty of efficient labor must be at hand. On Woodland Farm, in the year 1904, the spring was late so that alfalfa harvest was greatly delayed, the first cutting taking place on June 9. Twenty acres were cut down on that day, on Saturday, after being teddered once, it was put in cock; on Monday it was dry enough to begin going into the barn after dinner and twenty-two loads, averaging more than 3,000 pounds, were put into the barn. Two days later, beginning at eleven o'clock, there were put in more than forty large loads. To accomplish this, there were three men kept in the mow, another to work the rope of the hay carrier, one to work the forks, one to drive the team, a large boy to haul up the draughts, four wagons with drivers and four men in the field.

It is worth while thinking of the apparatus used for putting in this hay. A large carrier runs in the peak of the barn, over a mow thirty-five feet deep and with open center, no cross timbers at all. This carrier operates slings or uses two double harpoon forks at the pleasure of the operator. The wagons are equipped with platforms seven feet wide and sixteen feet long, with tight bottoms, low down. One sling is laid in each wagon at the bottom of the



load. No more are used because of the danger of the men in their haste placing them wrong in the load. When the wagon, with its load, drives to the barn there are first inserted two double harpoon forks, one in each end within about three feet of the edge, the rope having two blocks on a loup, each block with a hook in it. These hooks are attached to the forks, the team takes up the two forks with the whole top of the load, a third of it. The next haul is of the middle third, then there is left only what can be taken up by the sling, which leaves the wagon clear. The slings are thrown down on the wagon, put in place, and the driver goes for another load. All this takes from six to fifteen minutes. The line used in hoisting is an inch and a quarter in diameter, as the strain on it is very great, and this makes rapid working requiring two men to operate it. There is also a weight used to help bring back the carrier.

In one week, more than a hundred tons of hay were made without loss, part of it put into the stack. There was one day of constant rain and it was observed that the hay that was raked before the rain, being quite green, was hardly injured at all, retaining its leaves and color, while what was left in the swath bleached somewhat, thus emphasizing, what has often been observed before, that alfalfa hay is better raked green and cured partly in the windrow rather than left to burn dry in the swath. There can, of course, be such a thing as raking too green; but one should not let the hay dry till the leaves will drop before gathering it together. It is convenient to have other work to do on the farm during alfalfa harvest, as there are many hours when men can not be profitably employed in the hay. The best thing to do with that being simply to wait. On Woodland Farm there are fields of corn to work in and the perennial onslaught on farm weeds to keep up.

It is rather easier to cure alfalfa hay when mixed with grasses. There are not many suitable to be grown with alfalfa. Timothy is advised by some. Because its time of ripening is three weeks later than alfalfa, sometimes four weeks, orchard grass serves better and rye grass comes in fairly well. If the land is to be sometimes pastured, smooth brome grass (*Bromus Inermis*) is the best thing that can be sown with alfalfa, and it should be sown quite thinly, as it thickens rapidly and will, in time, become too thick for the alfalfa's best thrift. This brome grass has not been much used in the Eastern states, but has had wide introduction throughout the West. It likes good soil and then gives very heavy yields of hay and grazing, standing drought and heat and cold too, better than most grasses. Furthermore, animals are extremely fond of brome grass and eat it in preference to almost any other pasture grass.

This fact makes it hard to maintain brome grass in a mixture of grasses in pasture. If mixed with orchard grass, for instance, the animals seek the brome grass as long as they can find it, and finally almost exterminate it, leaving the orchard grass to thrive. Even Kentucky blue grass is neglected for brome grass.

In sowing brome grass with alfalfa, not more than ten pounds of brome seed should be put to the acre, else it will too early become thick and crowd out the alfalfa. Brome grass seed is not good if old and is hard to get pure of Eastern seedsmen. It is in plentiful supply in the Northwestern states and South Dakota produces it of fine quality. It is curious to note how much better brome grass thrives when sown with alfalfa than when sown alone. It is evident that the alfalfa, by enriching the soil, indirectly feeds the grass, which yields very much more than when sown alone.

An admixture of alfalfa and grass makes a better balanced hay as well as pasture. Animals confined to a diet of alfalfa hay will eat straw or corn stalks with relish, not because they dislike the alfalfa but because in the alfalfa they get more protein than they need and crave the carbohydrates that the straw or stalks give. In a pasture especially it is seen that animals hunt the grasses when confined mainly to alfalfa, though if the pasture is mostly of grasses the other thing is seen; they seek the alfalfa plants and gnaw them to the earth so that they are often destroyed.

It is necessary, when alfalfa is pastured, that there should be grasses mixed with it for the health of the grazing animals. Alfalfa grazed alone is apt to cause bloat or hoven in cattle and sheep. When grass grows with it they eat of each alternately and there is very much less danger from this cause. Bloat is, indeed, little but indigestion; there is not much well determined as to its cause, but this much is certain that it seldom occurs in pastures where the grasses and alfalfa are well mixed. The same is true of bloat from red clover.

#### GETTING RID OF GRASS AND WEEDS; DISKING.

There is sometimes too much grass and weeds in alfalfa. Mowing will usually destroy the weeds, but it only invigorates the grass. A good practice when grasses threaten to choke the alfalfa, supposing it to have become well-rooted, is to disk it thoroughly after growth sets in in spring and after disking to use a spike-tooth harrow to tear out as many grass roots as possible. There is little danger of injury to the alfalfa from this disking, though one should set the disks so as not to actually cut off the crowns. To set the disks fairly straight and to weight the harrow to make it cut deep is better than to set it quite angling, as it is much less apt to cut them

off. When crowns once are cut off, the root is destroyed, while merely splitting them is beneficial; but it is certain that a thorough disking and loosening up of the ground greatly stimulates the growth of the alfalfa. It is notable that this disking pays well if performed in spring and then again after the first crop is taken off. In Kansas it is customary to disk after each cutting. Just how the benefit comes is not exactly known, though the loosening up of the soil to admit air is doubtless a help and this also aids the retention of moisture.

#### NEED OF WATER.

It must be borne in mind that the yield of alfalfa hay in a year is directly proportioned to the amount of moisture in the soil during the growing season. The writer has cut as much as ten tons per acre in an irrigated valley in Utah where he had absolute command of all the water he could use. The soil there was loose and gravelly, of only fair fertility, but very deep and doubtless the alfalfa grew mainly from the water supplied, though there was much mineral in the soil, together with an excess of alkali. After each cutting there would be applied to the land about six inches of water which soaked to a great depth, and again just before harvest the meadow would be flooded. The rankness of that alfalfa was most extraordinary, and it can in no way be accounted for save by the loose character of the soil which admitted air readily and the floods of moisture which fed the plants.

Disappointment in the East often follows sowing of alfalfa because of its failure to do as it has done in irrigated lands when the fact of the deficiency of water is supplied the crop under Eastern conditions is not taken into consideration. It requires probably 400 to 500 pounds of water to make a pound of dry matter in the alfalfa plant. Therefore, a crop of say, six tons to the acre, during the growing season would use up the enormous amount of 3,000 tons of water during the season. This, in addition to what is usually wasted by evaporation from the surface of the soil. This is equivalent to about thirty inches in rainfall. The rainfall of Pennsylvania during the year is much in excess of that, but much of it comes at a season when alfalfa can not make use of it. It is, therefore, of prime necessity to make the land as able to hold and store available moisture as possible and at the same time to prevent its waste through evaporation from a hard-packed surface soil.

In truth there is no crop that will so thoroughly pump the moisture out of the soil as alfalfa. Down deep and from there to the surface the soil is filled with feeding roots and if the rainfall is deficient they finally extract almost every particle of water that the



soil contains. For this reason it is not always advisable to plant alfalfa in orchards, particularly in young orchards not already well-established. Old orchards having their root systems developed first are able to hold their own and, in fact, it is not easy to get a good stand of alfalfa under the shade of a tree. I have seen alfalfa to so dry out a clay loam soil that blue grass which had so run in as to threaten to choke out the alfalfa was dried out and killed, root and branch. This, of course, is most unusual and grasses, as a general thing, hold their own and more with alfalfa in the East.

The figures above are taken, however, from experiments made with the red clover plant, to show what amount of water is required to make its growth. In the case of alfalfa, a native of hotter and dryer climates, it is probable that there is less waste of water, that its leaves and stems are so made that they better conserve moisture and thus make much more growth with a given amount of water. Further experimentation is needed to definitely settle this point. Experience shows, however, that when alfalfa plants grow alongside of red clover plants of the same age, the red clover will dry up and cease growth, while the alfalfa plants are seemingly little hurt by drought. Any one who has lived in dry regions must have observed that there is a wide difference in the ability of plants to conserve moisture. Desert grasses and shrubs live and even keep green when there is no apparent moisture in the burning sand and cedar trees exist on heated rocks, with scarce enough soil to hide their roots, so it must be that alfalfa has the ability not only to search deeper for sources of moisture but to better conserve that which it finds.

Deep tile draining is a great help toward the retention of useful moisture. The fear that drainage will make soils more susceptible to drought is unfounded. Deeply drained soils have the added depth of feeding capacity so that roots can and will penetrate to much greater depths than when the lower soil is waterlogged part of the year. Then drained and manured soils become more loose and permeable and absorb much more water than soils allowed to puddle in a wet time and bake hard in a dry time.

The knowledge that alfalfa thrives under irrigation often leads to error in practice among Eastern experimenters who, therefore, reason that it should be sown on wet land, perhaps in a swamp. It will not live at all in land saturated with water for part of the year, nor is it generally worth while to sow it on peaty lands that have been reclaimed from the swamps. As a general rule, they refuse to grow alfalfa, owing to their acidity and general lack of mineral fertility. After the swamp has been reclaimed by manure,

lime, ashes and perhaps by the admixture of a certain amount of clay, alfalfa will thrive thereon; but it is not worth while sowing it on raw, peaty or mucky soils. Indeed, as a general rule, clays produce better alfalfa than black soils, though there are exceptions to this.

#### HOW TO RETAIN THE SOIL MOISTURE.

The maximum crop of alfalfa is made when all the moisture falling during the spring and summer is evaporated through the alfalfa leaves, together with what is stored in the subsoil by winter rains. To accomplish this the land should be disked as early as it is dry enough to work and again after the first crop of hay is taken off. By keeping the surface soil loose the capillaries are sufficiently broken so that the escape of moisture is greatly checked. Indeed, by this treatment very good crops of alfalfa are grown in dry parts of Kansas and Nebraska, where most of the moisture is stored from winter and early spring rains.

#### SUB-IRRIGATED LANDS.

Ideal soil for alfalfa outside the irrigated region is what is known as "sub-soil irrigated land," that is, land that is moistened from below by sheet water or springs. Along the Platte and Arkansas rivers there are wide valleys of sandy soil below which, at a depth of from four to twelve feet, there is constant water soaking in from the rivers. This under-moisture rises sufficiently to make alfalfa grow with great vigor and some of the best alfalfa lands in the world are along these rivers. Once established there, there is no care whether the summers are wet or dry, except that the preference is rather for the dry summer owing to the greater ease with which the hay may be made. It is found in these sub-irrigated valleys that it is not well for the water to stand closer than about three or four feet to the surface. When it comes above that the alfalfa makes much more feeble growth and soon perishes.

There are many situations along rivers in Pennsylvania and, indeed, along creeks, where alluvial deposits are found with sheet water down from three to ten feet and these alluvial soils will be found ideal places for alfalfa growing. It is safe to sow alfalfa where water does not rise higher than within three feet of the surface. It will not endure so long in so shallow a soil, but it will be very productive for a few years, when it may be plowed, planted to corn or other crops which will be immensely benefited by its having grown there and afterwards it may again be sown to alfalfa.

One of the most profitable alfalfa fields on Woodland Farm is on a creek bottom where, during some parts of the year, the water

raised to within thirty inches of the surface. It yielded tremendously for three years, when it began to die out and was plowed and planted to corn. It was particularly noticeable that during one very dry summer this field did not at all feel the effects of drought but made hay that sold for about \$60.00 per acre in the field.

#### IRRIGATION IN PENNSYLVANIA.

There are many places in Pennsylvania where there is water available for irrigation and some considerable breadths of land suitable for being irrigated. Any stream having sufficient fall to be carried in a level ditch or canal above the land will serve for irrigation, and any soil being sufficiently pervious not to become waterlogged and having sufficiently uniform slope to permit of easy flooding, will present suitable conditions for irrigation. That irrigation has been neglected for some centuries in our Eastern states is no indication that it would not be very profitable under suitable conditions and when rightly managed. In moist and cool England there are water meadows where irrigation is practiced, and has been practiced for centuries, that are of marvelous fertility, and their fertility is maintained from year to year without the addition of any manures. These meadows rent for yearly rentals as high as 3 to 6 pounds per annum, when adjoining dry lands rent as low as one pound.

One who has practiced irrigation in the West often marvels, as he rides over Eastern fields, and sees the opportunities almost altogether neglected. There are streams running to waste that would, if properly directed, increase the productiveness of the lands below them many fold. The fact is, there are seldom, if ever, years when, throughout the whole season, there is water enough for growing crops, and there are many occasions of severe droughts when irrigation would have made fortunes for the men who had it.

The first consideration in irrigation is water. Much more of this is needed than is generally understood. It is useless to think of irrigating fields from wells by pumping with windmills. It is folly to think of hauling water over fields or of sprinkling it from hose. If the volume of water available is small, it may be conserved in a reservoir until a considerable amount is stored, when it may be all used within a comparatively short time. A large volume of water turned on at one time is much more economical than a small stream continued for a long time, as the small stream soaks too deeply the near by parts of the field and leaves dry and remoter parts. In irrigating alfalfa, no water need be used the first year unless during very exceedingly dry years; in fact, it is better to use no water. After the first year, water should be sup-



plied abundantly immediately after cutting the first crop; it will seldom be needed before, and again after two weeks. It is well to let the ground be as dry as it will get just before haying time, but flood the meadow immediately after getting up the hay. The ditch should convey the water to the highest parts of the field and be all turned out in one place, letting the water pour in and spread over the land, being helped by use of the shovel to spread properly. When it has reached the lower end and has soaked sufficiently it should be all turned off at this point and turned to the next highest point. The length of time that it should soak depends upon the nature of the soil, an hour or two will serve for open soils, longer may be wise in clays, and damage will not follow the irrigation if it continue with running water for twelve hours. When it is turned off there should be no pools standing anywhere. The soil should rapidly absorb the water and the surplus should be taken up by the subsoil or discharged through tiles. Alfalfa will not endure stagnant water on the soil or in the soil and if the land is not drained naturally or artificially to a considerable depth, irrigation should not be attempted. When the land is drained with tiles, they should be laid deep, close together, with every care to prevent earth entering their joints and it is well if there is a slight ridge of soil directly over each line of tiles so that water may not ever stand directly over them and enter them without first percolating through the soil.

The labor of irrigating alfalfa once the ditches and canals are established is very small. The writer has alone irrigated nearly a hundred acres and had abundant time for other occupations in a land where no rain at all fell and irrigation alone made the crop. It is safe to say that under Pennsylvania skies, given a suitable soil and irrigation, the added yield of alfalfa would be not far from three tons per acre, which would pay for considerable labor and expense. Care must be observed not to let the ditches carry water to the alfalfa field in winter, when it may freeze and surely destroy the crowns of the alfalfa wherever it lays.

One of the great and everlasting benefits of irrigation from a stream is that quantities of fertilizing materials are constantly being washed down and deposited upon the field. Especially is this true during freshets and high water, when the amount of rich mud deposited on the land steadily and rapidly build it up. In the water meadows of England the ditches are now on top of ridges, caused by the steady deposit of silt along the sides of the ditches where the growing grass catches and retains it.



## ENEMIES OF ALFALFA.

*Alfalfa Dodder.*—Alfalfa has few enemies that are able to cope with it after it is well-established and when it is treated after the manner in which it should be treated. The frequent mowings kill most weeds, disking destroys grass, but there is one enemy that will surely and rather swiftly destroy it, root and branch. That is the little yellow-twining parasitic vine called alfalfa dodder. Dodder is not unknown to many farmers as a tiny, yarn-like vine seen growing wild on plants of the mint family and often binding into a tangled mass a large number of plants in a patch of spearmint. The habit of growth of dodder is very curious. It comes first from seed which is about the same size as alfalfa seed. The young vine twines about an alfalfa stem and sinks a root into that stem, drawing therefrom juice for its subsistence. Thence it goes on encircling other stems and sending out innumerable branches until all the plants near by are tied into an inextricable tangle.

This dodder has very tiny leaves of its own, no roots in the soil after it once gets a start, and is of an orange color. When once it is well-established in an alfalfa field it is useless to combat it, but the whole field should be plowed and cultivated for a few years before it is resown. If small patches are seen, however, they need cause no alarm, as they are comparatively easy to destroy and do not at first spread very fast. Cut them off, do not carry away or spread the mass around, but let it lie until thoroughly dry, then add more straw or dry hay and make a bon-fire of it all. This will eradicate it at once and the spot may be resown if the alfalfa roots are killed. Care should be taken not to save seed from dodder-infested fields. This alfalfa dodder, probably, lives on no other plant that we cultivate and is not, in a general way, a menace.

*Sweet Clover.*—There is a plant somewhat resembling alfalfa, the seeds of which are quite apt to be found mixed with alfalfa seed. This is the melilot, sometimes called Bokhara clover, the commoner name being sweet clover. It grows wild along roadsides and on banks, where the surface soil has been washed away. It is a rank-growing plant, with a leaf much like alfalfa, only larger and rounder and bearing a white bloom. There is a rather pleasant odor to the leaves. Sweet clover is a biennial—forming seed the second year and dying down, though self-sown seed may make it appear to be a perennial. It is not a bad weed, and in the alfalfa soon disappears under frequent cutting. In the South, animals learn to eat sweet clover, though they naturally refuse to eat it, and must be taught by necessity, yet chemical analysis shows it to be rich in protein.

Sweet clover thrives where there is abundance of lime in the soil and is, in a general way, a good indication that alfalfa may

be grown on that soil. It carries, according to Professor Hopkins, the same bacteria as alfalfa and will inoculate land for alfalfa. It is one of the best soil-enrichers and a good bee pasture. This much attention is given sweet clover, because men often confound it with alfalfa and, getting it started on their farms, are at a loss to know whether they are harboring a friend or foe. It is useful, but indirectly, as Pennsylvania horses and cows are not likely to eat it.

*Foxtail Grass.*—This annual grass is a pest in newly seeded alfalfa fields, and not infrequently gets the upper hand. There is no remedy after it once is established. To give clean, previous cultivation for a few years and rid the fields of its seeds, is about all one can do, though late sowings escape the trouble that earlier sowings have. Mowing it off checks it somewhat and gives the alfalfa a better chance; but mowing it does not destroy it. In Southern Pennsylvania, when favorable seasons occur, alfalfa may be seeded in August or late in July with success, when the foxtail will not trouble it. The previous preparation of this land for summer or fall seeding should be to plow a wheat stubble, or turn under a clover sod, work it thoroughly to fill it with moisture, work it again after weeds have started, and sow in a fine seed-bed, covering about an inch with fine soil. This can not be accomplished in dry seasons.

The really sure and safe method of sowing alfalfa is to take the land in hand in spring, disk it deeply, let it lie until weeds start or rains come, disk again, though if the rain has not packed it, the acme harrow will serve as well and be of lighter draught; then follow this practice of cultivation after every rain or after every crop of weeds has started until sometime in late June or early July, when the land will be clean, mellow, moist and in ideal condition for sowing to alfalfa. If now the soil is rich and inoculated and the seed sown and covered right, the subsequent rapid growth of the alfalfa will be a marvel to all who observe it, and by fall it will have a much heavier root than that which has struggled against weeds all summer.

After the first year, foxtail does not trouble in the first crop, but often appears in the second and third crops, where it is more or less of a nuisance, decreasing the growth of alfalfa and being itself hard to cure. The remedy here is to disk the land after cutting off the crop, or to scratch it very hard with a sharp harrow.

There are many perennial and annual weeds that appear in alfalfa fields somewhat, but they do not do much mischief and the frequent mowings which only invigorate the alfalfa, so weakens them that they finally disappear altogether.

*Moles, Gophers and Woodchucks.*—Alfalfa makes land fertile and fills it with humus; that causes worms and grubs to inhabit it more or less; that, in turn, brings moles upon the scene. They do no injury to the alfalfa, but their hills are a nuisance to the mower. It is not fair to poison the moles, even if it is practicable to do so, for their work is good for the alfalfa. A smoothing harrow will level their hills.

Gophers, in the West, work considerable injury to alfalfa fields, but they, in turn, are found to be greatly beneficial to the land and are not easy to destroy. They eventually run the alfalfa out, however. This pest has not yet reached Pennsylvania, we believe.

Woodchucks revel in alfalfa and get fat on it. Their holes are a serious nuisance. When they have a great den, with many openings, it is nearly impossible to destroy them, except by digging them out, but when there are but one or two openings they may be readily smothered with the fumes of bisulphide of carbon. This material is a liquid. It is poisonous and inflammable, so should be handled with care. The manner of using is to saturate a rag with a quantity of bisulphide of carbon, using about a tablespoonful for each opening, push the rag as far down the hole as you conveniently can and at once close the hole. It soon forms a gas that is heavier than air and settles to the remotest depths of the den, suffocating the inmates. All openings must be tightly closed and each one should be treated to a dose of the poison. It is not a dangerous substance to work with, only one should bear in mind that the gas is explosive and not have the bottle open near a light or fire. Should the den be dug out again it will probably be from the outside, and the treatment may be given again to care for the new tenants.

#### USES OF ALFALFA.

It would be folly to give so much attention to growing a plant that, when it was grown, was of but moderate value. Alfalfa deserves all the care and attention that it asks. It richly repays the farmer for his attention. He can grow no crop that repays him better. It makes more forage for domestic animals than any other, and better forage. It makes forage rich in protein, that element that goes to build tissue and blood, that fills the mother with milk and makes the bone and sinew develop in the young. For the baby and its mother, it is the ideal forage.

Alfalfa feeds deep in the soil. It uses all the soil. It uses all the soil water in drained soils. It uses all the growing season, needing not to be planted each year, but is there when spring comes with its root system developed ready to go to work with the first

warmth. It calls to its aid the bacteria that help it gather nitrogen from the air. Its rootlets dissolve the mineral elements from the soil. It makes rank growth of the best food we can grow for farm animals and it leaves the soil richer than it found it, at least, in available elements of plant food.

In comparison with other staple crops, the New York Agricultural Experiment Station at Geneva, has made a series of very valuable tests, as follows:

“FOOD VALUE OF SEVERAL FODDER CROPS.

“In order to show the high feeding value of the alfalfa from an acre, the average product obtained at this station during the three years past is stated in the following table in comparison with the food supplies by several of our best common fodder crops. The average of the five alfalfa crops was 34,104 pounds of green fodder, or 8,035 pounds of dry matter, containing 1,411 pounds of protein, 1,103 pounds of this being albuminoids:

	Yield per acre of total crop. Pounds.	Dry matter per acre. Pounds.	Total digestible matter per acre. Pounds.	Digestible protein. Pounds.
Alfalfa, .....	34,100	8,000	5,280	875
Corn, entire plant, .....	28,000	5,800	3,800	309
Red clover, .....	18,000	5,220	3,200	491
Oats and peas, .....	13,000	3,120	2,521	350
Timothy, .....	10,000	3,500	2,000	228
Rutabagas, .....	31,700	3,400	3,000	279
Mangels, .....	25,000	3,500	2,750	232
Sugar beets, .....	17,800	2,500	1,800	213

“The acreage yields of the several crops given above are such as have been secured at different places in this part of the country from Pennsylvania to Canada. Sometimes considerably larger crops have been obtained; but the average crop would be less than any mentioned in the table.”

This is, indeed, a wonderful showing. More carbohydrates than corn and nearly three times as much protein! And the crop of alfalfa, once the field is established, can be grown and harvested at much less expense than the corn, while corn impoverishes land on which it grows and alfalfa enriches it.



## SOILING.

The best manner of feeding off alfalfa is by cutting it fresh just about as it comes to bloom and feeding it at once to stock of any kind. Cut in this way, it is all digestible and all tastes good, so is eaten clean with a relish. There is doubtless some loss by turning to woody fibre in drying alfalfa into hay. There is no loss from trampling, as when stock is turned on alfalfa to pasture it down. There is little or no danger from bloat or hoven when alfalfa is cut and fed slightly wilted, or, indeed, not wilted at all. On Woodland Farm, where a great amount of alfalfa has thus been fed to cattle and sheep, there has never been a fatality from bloat nor, indeed, a case that required our treatment. The reason, perhaps, why alfalfa does not bloat when cut and fed green, while it may be that the same animals grazing it would bloat is, that when soiled they must eat it all, stems and leaves together, while when allowed to graze they nip off the tender, succulent leaves and these mass together in some way that starts the disastrous fermentation.

Calves and young cattle thrive amazingly when a rack is put in their grass pasture, which is heaped from time to time with fresh-cut alfalfa. The writer has seen, in France, great stock farms where nearly all stock was fed, in large, airy stone-built stables, fresh-cut alfalfa every morning, with dry straw freshly threshed in an adjoining manger. The cows had, at the same time, a small ration of ground barley and gave astonishing amounts of milk, while the sheep were pictures of thriftiness and content. The great Percheron mares and colts had also their ration of alfalfa.

On a ranch in Utah, where the writer once lived, it was the custom, in summer, to soil the sows and pigs with fresh-cut green alfalfa. They had no run but a small log pen, through which passed running water. Though fed no grain of any kind, they made good growth during the summer and rapidly put on fat in the fall, when fed an additional ration of corn and Hubbard squashes.

In the San Joaquin Valley, of California, are many very great alfalfa ranches and farms. The writer has seen there large dairies fed on green alfalfa and on alfalfa silage, it being found, there, better to ensiloe the alfalfa in order to soften the prickly beards of the wild grasses infesting the fields. The more common practice throughout the San Joaquin Valley, however, is to pasture the alfalfa in summer and feed in winter cut alfalfa that has been moistened and sprinkled with barley meal, about four pounds of the meal to thirty pounds of alfalfa, or even a less amount is often used and fed to steers, dairy cattle and, in fact, to all sorts of live stock.

New York has made valuable experiments to determine the cost

of milk made from alfalfa and from other sources of succulent forage. Concerning alfalfa on the Geneva Station farm, the bulletin (No. 80), says:

"Alfalfa has grown well on the station farm, although the soil is a rather heavy clay. A field of alfalfa of 2.28 acres, sown in 1890, yielded this season (1894) for the first two cuttings—the first during June and the second about August 1—at the rate of 24,500 pounds of green forage per acre. On account of very severe drought the third cutting was very light and only part of the field was cut for the fourth time. Another field of alfalfa of 1.3 acres, sown in 1893, yielded at the rate of 33,800 pounds of green forage per acre, as the total for four cuttings. The last two cuttings were very light on account of severe drought. The first two cuttings, from May 11 to 31, and from July 9 to 28, yielded at the rate of a little over 12 tons of green forage per acre. These fields had been steadily cropped and not well manured for some years before sowing to alfalfa, and were not in condition to produce heavy crops.

"The importance of feeding leguminous crops has led to many inquiries concerning the value of alfalfa as forage for milch cows, for the alfalfa is much liked by cattle and other animals and contains an unusually large proportion of nitrogenous constituents. The rapid growth of the plant, which can be cut three times during the season, and often four times, makes it especially worthy of consideration where soiling methods are practiced."

There follows an account of very careful and accurate experiments with cows, feeding various grain and hay rations, with green peas and oats, clover, corn silage and sugar beets. In every instance the comparison was in favor of the alfalfa, taking into account the ease with which it was grown and harvested and the improvement to the soil that follows its use.

The whole bulletin is well worth study, but there is space here for but the general observations:

#### "GENERAL OBSERVATIONS.

"These feeding trials here reported, though many of them for periods necessarily rather short, were repeated for several seasons and are the average results from a number of different cows, so that the indications which they all give of the value of alfalfa can hardly be considered accidental.

"The average of all the analyses made of the fourteen lots of alfalfa used in these feeding trials will give an idea of the general composition of alfalfa forage. The average composition of three

lots of mature corn forage might be considered beside that of the alfalfa for comparison as follows:

	Alfalfa forage.	Corn forage.
Per cent. of moisture, .....	75.10	71.80
Per cent. of ash, .....	2.28	1.20
Per cent. of protein, .....	4.48	2.27
Per cent. of true albuminoids, .....	3.53	1.97
Per cent. of crude fibre, .....	6.59	5.17
Per cent. of nitrogen-free extract, .....	10.26	13.46
Per cent. of fats, .....	1.29	1.10

"In determining the cost of milk, for purpose of comparison, for each period reported in the preceding tables, the cost of the food only was considered. The manurial values of the foods were not taken into account, although under favorable conditions the net cost to the farm of milk would be much influenced by the fertilizing values of the foods. The manurial values of rations containing alfalfa and of those containing highly nitrogenous grain foods would be much greater than of most rations, but except where especial attention is given to careful handling of manure, only a small proportion of the possible amount would be recovered.

"When alfalfa forage was substituted for some other food or the amount of alfalfa in the ration increased, there followed, in ten instances a decrease in the cost of the milk, in two instances a very slight increase in cost, and in two instances the cost of milk was practically the same. There was an increase in the yield of milk in seven instances, a decrease in four instances of about what might normally be expected to occur without change of food, and little change in yield in three instances.

"When the change was from a ration containing alfalfa to one containing less or no alfalfa, there followed an increase in the cost of milk in ten instances and there was about the same cost once. There was a decrease of the milk yield in nine instances, and an increase of the milk yield in two.

"When alfalfa was substituted for other foods in the ration or the amount of alfalfa increased there followed a decrease in the cost of fat in seven instances and an increase of the cost in six instances. There was an increase of the amount of fat in six instances, a decrease in five instances, and little change in amount twice.

"When the change was from a ration containing alfalfa to one containing less or none, there followed an increase in the cost of

fat in nine instances, a decrease in cost once, and there was about the same cost twice. There was an increase of the amount of fat in three instances, a decrease in three, and about the same amount of fat in five.

"When the change in the ration was to more alfalfa, or to alfalfa in place of some other food, there followed a decrease in per cent. of fat in milk in six instances, an increase in three, and little change in per cent. in four instances. When changed from a ration containing alfalfa to one containing less or none, there followed an increase in per cent. of fat in six instances and a decrease of per cent. in five.

"There has been usually an increase in milk yield accompanying the use of alfalfa, although there was often at the same time a decrease in the per cent. of fat. With alfalfa forage, rated at the same cost as other forage, there was generally a decrease in the cost of milk when the alfalfa was fed, and not much change in the cost of the fat produced.

"Corn forage (fully matured), in the results accompanying its use, has compared most favorably with alfalfa; but except in the form of silage it is only available for a short time in the fall before frost. Alfalfa is ready for the first cutting about the time of planting corn, and about as early as rye forage can be cut. The proportion of constituents also differ so widely between alfalfa and corn forage that these plants can not well be considered as substitutes for each other, but as supplementary. For making rations like those usually fed, coarse fodder and grain foods, in general cheaper than those used with corn forage, can be used with alfalfa. The more highly nitrogenous grains and hays fed with corn silage or forage, however, have a much higher manurial value, which is often of wide importance.

"The palatability of alfalfa or of corn (maize) is greater than of most other forage plants of rapid growth that will yield heavy crops. This is a matter of the greatest importance."

From his own experience, the writer believes that there is hardly a farmer in Pennsylvania who could not use a small field of alfalfa profitably in summer as a soiling crop. There are always dry times, when grasses fail and cows shrink in milk, there are pigs and lambs and horses, all of which relish green feed and, particularly, if it is the delicious alfalfa forage. It is an insurance against drought and an acre of good alfalfa cut and fed green to stock will give as much as ten acres or more of average pasture grasses.

#### EXPERIENCE IN NEW JERSEY.

The New Jersey Experiment Station, under Dr. Edward B. Voorhees and Clarence B. Lane, has made very valuable experiments with



alfalfa, and their success is most encouraging. Starting on a rather poor, gravelly soil they had to use a considerable amount of manures to make the alfalfa thrive, though they learned that after it was once well-established it required much less help of this sort. Their experiments, with the amount of forage that will grow on an acre, are most suggestive. We quote their table:

TABLE II.

"The Nutrients Contained in the Yields Obtained in the Different Cuts.

Station Number.	In—Tons.	Dry matter.	Ether extract.	Fibre.	Protein.	Ash.	Nitrogen—free extract.
1514, .....	9	3,060	120.6	820.4	657.0	345.6	1,116.0
1515, .....	7.73	3,613	134.5	1,113.1	629.2	347.9	1,388.3
1516, .....	4.89	2,533	104.6	642.5	442.1	212.2	1,130.6
1517, .....	2.75	1,666	60.5	388.9	298.7	146.9	771.1
1535, .....	2.23	913	50.4	142.7	300.7	92.3	326.9
Total, .....	.....	11,785	470.6	3,107.6	2,327.7	1,144.9	4,732.9
1518, .....	2.21	3,595	141.0	1,065.7	613.1	328.8	1,446.7
1533, .....	2.00	3,617	134.4	1,242.8	529.6	345.6	1,365.2

"It will be observed that the largest amount of dry matter was obtained in the second cut, though the largest amount of protein was secured in the first cut. Sample No. 1518 represents the nutrients contained in the 2.21 tons of hay when hauled to the barn, and which was made from the 7.73 tons of forage. There was a loss of moisture and a change in relative composition of the hay in storing, though the changes were not serious, and were quite evenly distributed throughout the various groups of nutrients, whereas the yield is more than five times that of any other crop included, besides possessing the further advantage that it requires less labor to produce it—the expense after the first year being limited to cost of manures and harvesting."

Experiments made to see whether alfalfa might take the place of purchased protein, such as wheat bran, brewers' grains and similar products showed that this substitution might be made without materially changing the amount of milk and butter-fat produced and with decided profit when the alfalfa was a home product. In this experiment, it cost, to produce 100 pounds of milk when alfalfa was in the ration, 58 cents, as against 70.7 cents when alfalfa was not fed and the cost of producing a pound of butter was 12 cents

with and 14.3 cents without. The summary of Prof. Voorhees follows:

#### "SUMMARY.

"1. The successful establishment of alfalfa requires:

- a. That the surface soil shall be well supplied with the mineral elements, lime, phosphoric acid and potash.
- b. That during the early growth of the crop, the weeds should be frequently cut.
- c. That the crops should be harvested preferably just before the plants are in bloom.

"2. The crop is well adapted for soiling and for hay. The average yield of green forage per acre for three years (including the first year), was 18.27 tons, equivalent to 4.57 tons of hay. The yield the third year from five cuttings was 26.6 tons of green forage, equivalent to 6.65 tons of hay, costing \$3.69 per ton.

"3. A feeding experiment showed that the protein in alfalfa hay could be successfully and profitably substituted in a ration for dairy cows for that contained in wheat bran and dried brewers' grains, and for this purpose is worth \$11.16 per ton, when compared with the wheat bran and dried brewers' grains at \$17.00 per ton.

"4. The use of alfalfa hay reduces the necessity for the purchase of protein feeds."

#### ALFALFA AS A PASTURE PLANT.

It may almost be said that alfalfa is unfitted for pasturing. Grasses grow by the increase in length of the lower parts of their stems and blades. They, therefore, do not suffer from being nipped off, as they can yet push up from below. Alfalfa, on the other hand, grows from terminal and lateral buds. If these are bitten off, growth must cease until new buds can form and growth starts anew. Again, grasses are safe pasturage and alfalfa a risky one, because of the danger of animals, in their greed, so gorging themselves that they suffer from indigestion and consequent bloat.

Notwithstanding these facts very many farmers pasture alfalfa with great profit and almost every man growing it will desire to pasture it more or less. The brief study of the conditions under which it may be most safely pastured will then be profitable.

For the good of the alfalfa, animals must never run on the field when it is frozen nor when it is soft and muddy. To tread on frozen alfalfa crowns is to destroy them in most instances. There-

fore, as soon as a hard freeze comes all stock should be taken away from the alfalfa field, and the gates locked.

For the good of the alfalfa, animals must not be permitted to gnaw it too close. A small bit of alfalfa thrown into a large grass pasture will soon be destroyed, without affording a great amount of feed, because stock will hardly eat any other thing while they can get the alfalfa, and it will have no chance to grow at all. It is hardly safe for a man to attempt to pasture his alfalfa while it is in the experimental stage. He should wait until he has established fairly wide breadths of it; then he can set aside portions of it for that purpose.

A combination of pasturing and feeding off is most economical and satisfactory. Divide the area to be pastured into three lots. Turn in stock on one, and when they have eaten a part of it, turn them to the second enclosure and mow off the first, taking away what they have left. There are always parts of the pasture more palatable than other parts; animals thus graze unevenly; the mower evens it up, and what was discarded in summer proves to be acceptable in winter. After grazing down the second enclosure sufficiently, the animals will be turned to the third part, while the mower will finish cutting the second lot. Then, after a time, they will come back to the first enclosure, which, by this time, will be all evenly grown up and about at the blooming stage. Managed in this way, alfalfa will endure grazing for many years without injury, while, if allowed to be eaten close in spots and not eaten at all in other spots, it soon becomes weakened and grass invades it and the good stand is lost.

#### DANGER FROM BLOAT.

There are stages in the growth of alfalfa when it is much more apt to bloat stock than at other times. When the soil is moist and the weather warm and growth rapid, when the soil is very rich also, there is induced a very rank growth that is quite apt to cause trouble. This danger is worst when the alfalfa is young and tender; increasing safety comes with advancing maturity until, when it is thoroughly in bloom, there seems little danger to animals accustomed to its use.

Perhaps there is never absolute safety in pasturing sheep and cows on alfalfa, yet the writer has, for many years, pastured valuable sheep all summer on alfalfa, with a run on grass when they wished; and in some years his loss has been so trifling as to be not worth considering, while occasionally it has been necessary to take the sheep off for a time to allow the alfalfa to harden up. With cattle, after several years' experience, he has lost but one, and

that one from permitting them to graze very immature alfalfa that had been mown about two weeks and that, owing to the nature of the soil, was making a very rank growth. There is never danger with pigs, so that they are not too hungry when first turned on the alfalfa, nor with horses if it is not too watery and immature.

It is, however, an art to accustom animals to eating alfalfa in pasture. The plants should have made a considerable growth, almost having reached the blooming stage, before being turned on. This occurs, in Pennsylvania, about the middle of May, as early as one usually can turn to pasture profitably.

The animals, whether sheep, cattle or swine, should not be hungry when turned on. They should be allowed to fill themselves completely with blue grass, should have a ration of their usual grain, if they are eating grain; then, at about ten o'clock, when they do not care to graze longer, they should be introduced to the alfalfa pasture. It is well to stay with them until they have eaten what they will of the new forage and laid down to digest it; there will not be much tendency to bloat, but should there be it is well to be on hand. Being turned on at this time of day and stage of repletion, they will not consume very much alfalfa at first, and this is what you desire. Once filled up, the subsequent treatment is charmingly simple, they must never again be taken away from the alfalfa, night or day, rain or shine! The philosophy is that treated thus they never become hungry and thus take in but a little alfalfa forage at a time.

The usual practice of turning in for fifteen minutes the first day, half an hour the second day, an hour the third day, and so on, is the worst possible to conceive, as it brings the cattle every time hungry to the field, and in fifteen minutes they can pack an immense amount of alfalfa into their stomachs. With sheep, we have permitted them to leave the alfalfa fields during the heat of the day and come to the barn for shade and water. About ten in the morning, earlier during very hot weather, they would do this, and then at three or four in the afternoon they would be driven back to the field. Thus, they were on alfalfa all night and most of the day, and often with alfalfa hay in the barn to eat dry while sheltering from the sun.

The advantages of alfalfa pasture for sheep are great. Grazing high from the ground they escape taking in all sorts of intestinal parasites that so afflict sheep in America. The deadly stomach worm (*strongylus contortus*), once a scourge on Woodland Farm, has almost completely disappeared from evidence since alfalfa pasture has become our reliance. These parasites find their way to the ground from the droppings of the ewes, the germs develop there some-



what and perhaps by entwining about the moist grass are again taken into the stomachs of the flock, this time to distress the lambs. Intestinal parasites have very nearly ruined the sheep industry of Pennsylvania and Ohio. The old pastures become deadly. Alfalfa pasture has certainly been proved to be a remedy.

In a flock of a hundred ewes with their lambs, it has been usual with the writer to lose, presumably from alfalfa bloat, from one to half a dozen sheep and lambs during the summer. From stomach worms it was once his expectation to lose twenty, and half the others to be seriously injured by the presence of the insidious scourge. The nodular disease also seems held in check by alfalfa pasture, and tape worm is unknown in the writer's flock, for no other reason that he can see than that of the grazing of alfalfa. Of course, when grazing alfalfa one should be careful that the sheep do not infect themselves in other small grassy lots where the short, sweet, rich grass may tempt them to bite close, for in these places infection lodges.

#### CURING ALFALFA BLOAT.

Very often animals slightly bloated recover unaided. If, however, there is considerable distress the attendant should go at once to their aid. With sheep, to take a stick about two inches in diameter, or a large cob, inserting it between the jaws, thus keeping the mouth open, raising the head and gently pressing the sides between the knees will usually result in causing the gas to be belched off. A half pint of raw linseed oil, with a teaspoonful of turpentine added, is a relief, and the same mixture in larger doses relieves cattle.

When it is evident, from the extreme tension of the paunch, that this will not be enough to save the animal, recourse must be had to the trochar. At a point on the left side the walls of the paunch and the skin unite in the cow and are close to each other in the sheep. Here an insertion may be made without causing the animal much pain, and a tube put in to allow the gas to escape. When pasturing either alfalfa or red clover, a trochar should always be at hand, for there is no telling when it may be needed. The trochar is better than the knife, as it opens a small hole and there is no danger of opening one too large; then, when the point is withdrawn the tube remains in the opening, through which the gas escapes. In using any improvised tube one must hold to it or it may slip completely within the paunch and be lost, perhaps to the serious injury of the animal, though the writer once lost a piece of cane reed six inches long in the paunch of a sheep with no ill effect that he could ever discover, though what became of it has been always a mystery to him.

After using the trochar, one should liberally disinfect the wound with turpentine or some carbolic disinfectant.

In cases of bloat there is always considerable heat about the paunch, and, indeed, the rapid fermentation must produce an entirely unnatural heat which, if it can be reduced, may, of itself, cure the complaint. The writer learned from a Mormon ranch woman many years ago that ice heaped on the distended back of a bloated cow, with some kneading and keeping her head up hill, was a ready relief. This occurred when the ranch cows used to graze on frosted alfalfa in the fall and ice was at hand in the irrigating ditches. He has cured bloated ewes by pouring cold water on the region of the paunch.

Thus much space has been given the subject of bloat, not because it is indeed so very dangerous, but because when once one has a case of it on hand he is anxious to know at once what to do. The writer has noted that in years when he has had trouble from bloat on his alfalfa, his neighbors have had as much trouble and more loss from bloat on their red clover, and what is good treatment for one instance is for the other.

#### ALFALFA DANGEROUS AFTER FROST.

There is a time when succulent alfalfa may be frosted and afterward become very indigestible and dangerous to pasture off green; in fact, not the best food when made into hay. It is, therefore, a safe rule to at once and for the rest of the year to take all stock off the alfalfa pastures after a hard frost. It is well to leave a growth of twelve inches to catch the snow and protect the crown and the greatly increased yield the next year will much more than offset the small loss from not eating every bit of the crop in the fall.

#### MIXING GRASSES WITH ALFALFA.

Reference has previously been made to the value of grass mixed with alfalfa pasture when it is to be grazed, and, in the writer's experience, certain alfalfa fields that have in them considerable blue grass and brome grass have never given one case of bloated stock. Alfalfa sown thinly is also much less apt to bloat stock.

#### GRAZING SPRING LAMBS ON ALFALFA.

The writer has, for some years, made a practice of growing winter lambs. All the ewes would not yearn early enough to get their lambs off on the early markets, so those born in March and April would be left to go to pasture. It has been his practice to put

these ewes and their lambs on alfalfa pasture about the first of May, some years a few days later, and feed the lambs ear corn in creeps. These lambs have made astonishing growth thus treated, averaging above 80 pounds in June, and the ewes, without grain, have fattened while suckling their lambs. Lambs eating corn and suckling their mothers, have never suffered from bloat in the writer's experience.

#### GRAZING PIGS ON ALFALFA.

Alfalfa is the natural food for swine. The pregnant sow on alfalfa pasture generally needs no grain at all; at most, but a trifle of corn should she be in a thin condition when turned to pasture. Pigs born from sows pasturing alfalfa are unusually fine and strong. After they come the sows need a little more grain than before, and suckle profusely. The little pigs enjoy the sweet, tender herbage and thrive on it, but they, too, should have a daily allowance of grain. This is not absolutely necessary, as in Colorado, Western Kansas and Nebraska, many hog ranches are found where no grain is produced or fed, winter or summer, but only alfalfa hay dry in winter and alfalfa pasture in summer, but the pigs are often sold to farmers in the corn belt to be fattened. It is economy to feed corn on alfalfa pasture. Alfalfa alone is too one-sided a ration; it is too rich in protein and too poor in starch and fat. It builds the pig long and lean unless corn is added, but the amount of corn should be very much less than is needed on other pasture. In Kansas, the State Agricultural College has found that "at this station, pigs were pastured throughout the summer on alfalfa with a light feeding of corn. After deducting the probable gain from the corn, the gain per acre from the alfalfa pasture was 776 pounds of pork. One lot of fattening hogs was fed all the corn they would eat, another lot all the grain and dry alfalfa hay they would eat. The lot having alfalfa hay made a gain of 868 pounds of pork per ton of alfalfa hay."

#### ALFALFA PASTURE FOR HORSES.

There is nothing else so good for horses as alfalfa pasture. Working-horses keep in good flesh and work well, with a trifle of grain added to their daily run on alfalfa; especially is it good for mares and their foals. The mares give a great abundance of milk when having alfalfa green and the colts make a growth and development that is surprising. The writer, when visiting the great ranches along the Sacramento and San Joaquin valleys, in California, was constantly astonished at the size and quality of thoroughbred and

standard bred horses and colts running on alfalfa pasture in summer and wintering on alfalfa hay in winter. There is such an abundance of flesh and bone-forming material in alfalfa that colts develop naturally and to their utmost when fed upon it. No ill results whatever have ever been observed by the writer from depasturing alfalfa by horses, though he would not put them on it too early in spring nor when too hungry.

#### ALFALFA AS A BEE PASTURE.

In California, Nevada, Utah and Colorado, alfalfa honey is a staple article of commerce. The writer has seen some marvelous things in the way of alfalfa-fed bees. At Governor John Sparks' ranch, at Reno, Nevada, the bees took possession of the space between the weatherboarding and the plaster of his dwelling. From this they were dislodged from time to time and robbed, at one time yielding near a ton of honey. At the Chowchilla ranch, near Merced, California, bees inhabited a hollow wall of a granary. Their store yielded 3,000 pounds of honey at one time. Stranger still, in the peak of the roof of a farm building there hung pendant a mass of comb and honey at least twelve inches thick and eight feet long, hanging down three feet or more. This was about to be removed for fear it would fall of its own weight.

In Colorado, the production of honey has fallen somewhat in the sheep-feeding district, since alfalfa has been cut earlier, before it has come much into bloom. This fact of necessary earlier cutting will prevent the bees making so much use of alfalfa in Pennsylvania as they do in the pastoral regions of California.

Experiments made by the Kansas Experiment Station showed that bees were very necessary to the development of alfalfa seed. Whether there may not be other insects than the honey-bee that assist in this work, is a question yet to be definitely determined. It is certain that alfalfa seed is abundantly produced only in dry seasons. Possibly, in dry seasons there is more honey in the blooms and, therefore, more to entice the bees.

It is well to warn Pennsylvania farmers that seed growing with them will rarely be practicable, owing to the usual excess of rainfall, though in seasons of drought alfalfa will seed as well with them as anywhere.

In this connection it may be said that the odor arising from a field of alfalfa is the most pleasant and delightful imaginable. Nor is there anything that so beautifies the landscape as smooth, ever-green alfalfa fields, without a weed or any disfiguring thing, speaking eloquently for the future welfare of the soil, the live stock and the farmer as well.



## FEEDING VALUE OF ALFALFA HAY.

The following table, from the Kansas Experiment Station, gives some comparative values of alfalfa and other well-known feed stuffs. The figures are for the digestible matter found in the various feeds. These figures were gotten from the results of feeding experiments at that Station:

	Protein.	Carbohydrates.	Fat.
Alfalfa hay, cut ten per cent. in bloom, .....	13.24	39.26	0.89
Alfalfa hay, cut half in bloom, .....	11.90	40.26	0.39
Alfalfa hay, cut in full bloom, .....	10.43	43.17	0.69
Red clover hay, .....	6.58	35.35	1.66
Timothy hay, .....	2.89	43.72	1.43
Prairie hay, .....	0.61	46.90	1.97
Corn fodder, .....	1.93	33.16	0.57
Kafir-corn fodder, .....	3.22	48.72	1.15
Wheat bran, .....	12.01	41.23	2.87

The comparison with other forage crops shows a surprising superiority for the alfalfa; but a yet more astonishing thing is the comparison with wheat bran. These figures are, doubtless, for a good quality of alfalfa, well cured and the leaves all on it. Ordinary alfalfa is not as rich as wheat bran. Yet there is no doubt whatever that alfalfa hay can take the place almost completely of wheat bran in feeding cows, sheep and, in fact, all classes of farm stock.

Where bran is richer is in the amount of fat contained and again in the greater ease with which it is consumed, being in a ground state and requiring no mastication. It is actually true that alfalfa hay early cut and well cured is rich enough to sustain human life without burdening the person with an inordinate amount of material. There was a time in the early history of Utah, when grasshoppers took their grain, that they were saved from starvation, while another crop was growing, by eating alfalfa greens. Alfalfa leaves, fed in comparison with wheat middlings at the Nebraska Station, made slightly more pork than the wheat middlings, pound for pound of material used.

In the dairy ration, alfalfa is more and more taking the place of other and higher-priced protein concentrates. Alfalfa hay and corn silage alone make a large milk flow. If, then, a trifle of ground oats or wheat bran be added, not for sake of the extra amount of nutrients needed, but to make the labor of mastication less, the maximum result is secured at the least cost. Where the grain ration has been 10 to 14 pounds per day with alfalfa hay it may be cut down to half or less, especially if silage is provided. In truth,

orn silage so perfectly supplements alfalfa in the dairy ration that they should never be separated. Calves destined for the dairy herd are unusually thrifty and vigorous when fed alfalfa hay, and the tendency to lean flesh is stronger, together with normal and healthy development.

#### ALFALFA IN THE SHEEP-FOLD.

Sheep relish alfalfa exceedingly. Sheep need foods rich in protein more than other stock. Cattle and horses will thrive better when fed a too carbonaceous ration than sheep. Deprive the flock of its protein foods and you have certainly taken from it its chance of profit.

In winter time pregnant ewes having alfalfa hay with access to bright corn fodder or oat or barley straw to give a little more of the carbohydrates, need no grain at all and drop large, finely developed lambs. In truth, if alfalfa hay alone is fed to some ewes of breeds given to delivering large lambs, the development of the unborn lamb may be too great for safety, so that it is wiser to make a part of the ration of corn fodder or straw, which contains much less bone and muscle-making material. Ewes eating alfalfa hay during pregnancy have udders well-filled with milk when the lambs are born. This makes the shepherd's cares light at that anxious time. Ewes suckling their lambs will milk well on alfalfa hay with a trifle of grain in addition. Lambs born in winter will, with bright alfalfa hay and a ration of cracked corn, develop rapidly and make prime lambs for the fancy "hot house" trade.

The writer was, perhaps, the first man east of Colorado to begin fattening lambs with alfalfa as the hay ration. His earlier practice was to feed timothy hay, shredded-corn stover, oat straw and clover hay. To balance these fodders, deficient in protein, he bought wheat bran and oil meal. The result was satisfactory, except that the cost of making baby mutton was excessive. These lambs were fed from November till April, being bought from Western ranges or from farms. About the average cost during the early '90's was \$6.25 per hundred pounds for the gain put on. Concentrates rich in protein grew steadily dearer and lambs cheaper, so that it seemed that the end of his lamb feeding was near, when he turned his attention to producing an abundance of alfalfa. He found that as good lambs could be made with alfalfa hay and ear corn only as he had been making with shelled corn or ground corn and oil meal and wheat bran. The alfalfa-fed lambs developed a little slower, but made the gain much cheaper and with a lessened death rate. For some years the cost of producing lamb mutton on alfalfa hay and ear corn averaged about \$3.50 per hundred pounds.

It is his present practice to give the lambs a longer feeding time, buying them in November, giving little but alfalfa for a month, then a trifle of corn, gradually increasing until, in March, they may get nearly as much corn as they will eat. At no times does he feed all the corn they would eat. Nor does he feed more alfalfa than they will eat clean, saving that some coarser stems are allowed to be rejected. In April or early in May the lambs are sold and they have topped the markets for years, and are watched for by buyers in Buffalo.

The manure made by these lambs, fed under shelter, is returned to the land where corn is to be planted, usually an old alfalfa sod, after one crop of corn, or, at most, two crops, the land is sowed back to alfalfa again. This manure is very rich and by this system of farming the productiveness of the place is steadily and rapidly growing.

The writer has courage to make this plea for alfalfa culture because of the results that have come to him in his own practice. Since taking up alfalfa and stock feeding as a business, the productiveness of the farm has doubled and the income has quadrupled. More will be said of this feature of alfalfa growing under another heading.

#### ALFALFA FOR HORSES.

The noted race horse, Cresceus, was principally grown on alfalfa hay, and it is said that he eats alfalfa hay while on the racing circuit. Very many thoroughbred and standard-bred horses in California are largely developed on alfalfa hay. Many Percherons and other fine horses in France eat alfalfa hay, with other legumes. That, in large part, accounts for their size, bone and general development. The disappointment that often results in attempting to breed large draught horses in America comes from failure to provide suitable forage in generous amounts. Timothy hay and corn fodder have in them too little bone and muscle to make a colt grow as he should. Coarse forage, rather than grain, is the need of the draught colt, but it must be a rich forage, such as alfalfa provides. Working horses and driving horses relish alfalfa hay and keep in fine condition when fed upon it, with half the grain usually provided. The best grain to feed a horse eating alfalfa hay is corn. Oats have not enough of carbohydrates in them, though, of course, oats will serve; but corn is not only more suitable but generally cheaper to grow or buy.

Alfalfa, to be fed horses, should be permitted to ripen more than when fed to sheep or cows. It should be dried sufficiently in the field, so that it will heat very little or none in the mow. There will, then, be no dust upon it at all. There is no hair on the alfalfa

leaf, so that source of dust in the red clover plant is avoided. Half-spoiled alfalfa hay is not fit for horses. No ill results whatever follow feeding a moderate amount of rightly cured alfalfa to horses. When unused to it, there may, for a time, appear to be a freer action of the kidneys than usual, with more copious urination. This disappears in a few days, however, and the only unusual effect observed is that the horses are plumper, brighter, more enduring and in better spirits. After eating alfalfa hay for some time, however, they take very unkindly to any other forage, almost refusing timothy, thus showing plainly that their very instincts tell them what is best for them.

It should, however, be borne in mind that alfalfa hay is a rich food, and horses with mangers stuffed full of it may eat too much. It is better, therefore, to give them a definite amount at a feed and let them satisfy their longing for employment in the way of eating by permitting them to finish on bright straw, though for driving horses that should not be stuffed with anything the straw is unnecessary.

There are reports now and then to the effect that horses have been seriously injured by feeding them alfalfa hay. When traced down, these cases are all proved to be instances of feeding mouldy alfalfa or alfalfa cut too green, or to have in them no truth at all. The writer feeds no other hay on the farm to any class of horses, and has had no case of heaves or sickness of any kind since adopting this system, but has found it much easier to keep the working teams in condition than ever before.

#### ALFALFA FOR SWINE.

The hog is naturally one of the most healthy animals on the farm. Indeed, in a state of nature nothing ails hogs but starvation or old age. On farms, they are among the most subject to disease. Why is this?

In a state of nature the hog is a grazing animal. He does not discard nuts, fruits and grains, but the greater part of his food must be of forage of various sorts. The intestinal tract is then designed for bulky foods. In a state of nature the hog is not confined to a pen; he roams about and keeps clean, eating everything in his path.

Shut away from the ground, not permitted to graze, fed on concentrated foods that do not properly distend and strengthen the intestinal tract, the hog becomes subject to the most deadly diseases, so much so that "hog cholera" becomes the scourge of neighborhoods and counties. Hogs pastured on alfalfa seldom contract cholera. In winter, when corn must be their chief diet, if they have, in addition, what tender, early-cut alfalfa hay they will eat, they



will not only grow much faster but will keep in far better health and vigor; especially does the pregnant sow thrive when fed chiefly on alfalfa hay. It keeps her stomach and intestines at work in a natural way; it nourishes her properly, she comes to farrowing time strong and well nourished; her pigs are born strong and she has no unnatural desire to consume them.

She has an abundance of milk for them. After farrowing, she will need more of concentrated foods to keep up the milk flow, but the alfalfa forage should be given as before.

Very young pigs will eat alfalfa leaves and the tender parts of the stems, but they may be helped to masticate this food by wetting it for a time, and, better yet, by cutting it very fine, moistening it and sprinkling over it finely ground corn meal or wheat middlings. In Nebraska, some large pig growers in the western part of the state, beyond the corn belt, make a practice of grinding alfalfa into meal and feeding it to young pigs. This may be profitable, though it would seem to the writer, that to choose early cut, nicely cured, tender alfalfa hay, letting them eat what they wished and discard the rest, would be cheaper, counting cost of machinery and grinding. The size of one's operations would, of course, have a large determining influence here.

#### ALFALFA MEAL.

This alfalfa meal is now a regular product on the market. It has about the same nutritive value as wheat bran, but is generally sold for about \$40.00 per ton. It is a favorite food stuff with some Western poultrymen, and seems to induce a good winter egg flow. It would seem to the writer, however, that finely chopped and moistened alfalfa hay, with a little wheat middlings added, would be as useful and much cheaper.

#### ALFALFA FOR POULTRY.

Poultry relish alfalfa green and consume large amounts of it. Indeed, if a small plot of alfalfa is sown near the poultry yard, the fowls will nearly destroy the young plants before they get large enough to endure the continual pecking. When fowls are yarded, they will consume large amounts of green alfalfa, cut daily and thrown to them. In winter, they eat alfalfa hay with relish and it supplies them with a great amount of the necessary protein for egg-making. On the farm of the writer, guinea fowls run wild in the alfalfa meadows, requiring no food nor attention during the warm months. They lay great quantities of eggs, which are uncovered when the meadows are mown. Doubtless, these guineas help, to some extent, to keep injurious insects in check.

## ALFALFA FOR BEEF CATTLE.

The feeding of beeves is not so much of an industry now in Pennsylvania as it once was, owing to the competition of the West and the high prices of food stuffs. The production of beef in the old-fashioned way, by purchase of two or three-year-old cattle and fattening them mainly on grain, will likely never again be much practiced east of the corn-belt proper. Yet there is a form of beef-making that fits in well with Pennsylvania farming, and that has in it a sure and steady profit; that is the growing of baby beeves upon the farm. These may come from the dairy cows and it is not absolutely essential that the cows should be of the beef breeds, though the sires must be beef sizes, Angus, Shorthorn, Hereford or Red Polled. The calves are fed on separator milk, preferably from the hand separator kept upon the farm, and separating the milk while yet sweet. These calves eat grain from the beginning with good, sweet hay. They do not suffer a day's check in growth or development, and are made into ripe and finished beef when from twelve to eighteen months of age.

These "baby beeves" now command fancy prices in the market, and are made at less than half the cost of older animals. The prime need of these little beeves is an abundance of easily digested and nutritious food, especially food rich in protein. This the alfalfa supplies best and cheapest.

The best ration for these calves is, at first, skim-milk and cracked corn, soon changing to skim-milk and shelled corn, with always what good alfalfa hay they will eat. When summer time comes they either graze alfalfa and take refuge in a cool basement barn during the heat of the day, or are soiled with fresh-cut alfalfa in the barn and given the run of a grass lot. Corn or other grain is regularly fed to them every day. These calves will weight 1,000 pounds at a little more than a year of age, and will command the top of the market when weighing from 1,200 to 1,400 pounds. The silo filled with corn comes in good play when feeding these baby steers. There should never be a day of their lives that they did not have every bit of good nutritious food that they could possibly consume and digest.

## ALFALFA SILAGE.

The writer has made alfalfa silage accidentally in stack, and found that cattle eat it greedily. He has seen it fed with first-rate results in California.

A bulletin of the Colorado Station thus summarizes the results of tests of alfalfa as a silage crop:

"Some tests were carefully made on a small scale to see what

losses might be expected in making silage of alfalfa. One test was made with the alfalfa put in whole as cut in the field, the other with the alfalfa cut to quarter-inch pieces as we cut our corn for silage. The whole alfalfa showed a spoiled layer three inches thick on the top and an inch layer around the side nearly all the way down. The silage of the bottom and middle was excellent and was greedily eaten by the cows and calves. Its loss in the total weight was 10.7 per cent., but its loss in feeding value was probably a little larger.

"The other silo was filled with cut alfalfa. The next day the silo was covered with two thicknesses of building paper and one of boards and weighted with stone to about 55 pounds per square foot. When covered, the silage was hotter than the hand could bear. Two days later the temperature had fallen to 83 degrees F., and in two days more it had fallen to that of the air. The silage shrank and settled a good deal. When put in it contained 33 per cent. of dry matter. On opening, the silo showed two inches of spoiled silage on top and half an inch on the sides. The spoiled silage was 7.3 per cent. of the total weight. The loss in dry matter was approximately 10 per cent.

"It is fair to presume that with a good tight silo, well-made silage from cut alfalfa should not make a larger loss than was here given in our small experimental silo, or about 10 per cent. of its feeding value. To make good silage from whole alfalfa is a much harder proposition. It requires that the alfalfa be quite green; that the silo be both tight and deep; that the alfalfa be thrown into the silo in small forkfuls and carefully tramped, and that it be weighted by four to six feet of some heavy, tight packing material like cut-corn fodder. If the alfalfa is put up in the middle of summer in clear, bright weather, it must be raked and loaded as fast as cut. One lot we tried was too dry for silage two hours after it was cut."

It would seem that when the weather is favorable it is better to dry the hay and store it than to handle so much water as would be handled in putting green alfalfa into the silo. There is, however, a result from feeding silage, especially to animals giving milk, that can not be secured from any dry ration. As to the cost of alfalfa silage, the Kansas Experiment Station (which has done invaluable work along alfalfa lines) reports that their experiments indicate that alfalfa silage can be made more cheaply than silage from any other source, the alfalfa silage costing \$1.63 per ton in the silo against about \$2.20 for corn. The writer believes, however, that corn silage to supplement alfalfa dry hay is best and most practicable. However, at silo-filling time there may be put in layers of green alfalfa, raked as fast as cut, which will form nearly a balanced ration with the corn.



## ALFALFA AS A SOIL ENRICHER.

Alfalfa enriches soils in three ways. It roots deep and dissolves the inert mineral substances from the lower lying strata of soil. It brings these mineral substances, potash, phosphorus and lime to the surface. Its roots open the soil so that air may penetrate it and water more readily drain away. It fills the soil with humus and the decaying vegetation, within the soil attacks other mineral elements that are locked up and sets them free.

Added to these benefits we must not forget the nitrogen-gathering bacteria that inhabit the alfalfa roots. Experiments made in Germany with a great number of leguminous plants have shown that alfalfa gathers more atmospheric nitrogen per acre than any other. It is not true, however, that one can with alfalfa bring up a poor soil. Alfalfa will not enrich a poor soil, for it will not be possible to establish it in a poor soil. There are other legumes that very usefully precede alfalfa, on poor soils. There is sweet clover which thrives on any poor soil having sufficient lime and potash; there is hairy vetch which grows in soils deficient in lime and greatly enriches them; there is the cow-pea, which thrives where there is little humus in the soil. Any one of these is better for a worn soil than alfalfa, and common red clover is as well, but after the soil has been enriched and stored with sufficient humus, alfalfa will take possession and give back an immense store of available richness that may be applied in part to another plot needing help.

To say nothing of the roots of the alfalfa, the tops in a season, if yielding five tons of hay, will yield fertilizing elements worth, in comparison with bought commercial fertilizers, from \$50.00 to \$60.00. Prof. Buffum, of Wyoming, has shown that the roots are worth, in Wyoming, for increased crop production, above \$19.00 per acre. Certainly, if the hay is cut and sold there is steadily removed from the soil a very considerable amount of its mineral fertility and ultimately that soil will become depleted of these elements, even though it remain stored with nitrogen, but when the forage is fed upon the farm and the manure carefully applied to enrich other fields, which, in turn, will be sown to alfalfa when sufficiently brought up, the gain is very great and increasingly rapid as the alfalfa more and more gets possession of the farm. The writer has seen on the farm belonging to his brothers and himself the total productiveness of that farm nearly quadrupled in fourteen years by this course of growing alfalfa and feeding it to animals, returning the manure carefully to the parts needing it the worst.

On limestone clays, alfalfa has a curious way of maintaining itself without help after once it is thoroughly rooted. It may require heavy manuring and deep plowing to get it established, owing to



the unreadiness of the soil, but after that it has been observed to yield very heavily for a long series of years with no more aid, steadily giving back the help loaned to it and in turn greatly enriching other fields. On soils deficient in mineral elements alfalfa will need annual dressings of phosphorus and potash, with possibly a light sprinkling of manure, but these soils are not common in the better parts of Pennsylvania.

#### PLOWING ALFALFA SOD.

Alfalfa is difficult to break. The roots are very large and tough, and resist a plow to the utmost. It is much harder to plow than clover sod. The plow for alfalfa should be a walking plow, strongly made and of good pattern. It should be provided with two steel shares, one of which should be sent to the smith to be sharpened while the other is in use. The plowman should also be provided with flat files and at intervals of about twenty minutes he should turn the plow out of the ground and file the edge of the share sharp. There need be no time lost while he is doing this, as the team will need the rest and it takes but a few minutes to bring the share to an edge if given this frequent attention.

Besides this there should be affixed to the landside of the plow, a wing running flat in the bottom of the furrow and extending out three inches into the uncut soil. This wing cuts off the roots of the edge of the next furrow to be turned, so that the plow will only have to contend with those farthest away from the edge of the furrow and firmly fixed in the soil. It aids immensely to use this wing in ease of plowing and steadiness with which the plow runs. It should not run squarely back from the bottom of the landside, but diagonally so that roots will not catch on it and make it throw the plow out or draw badly. With the best of plowing, one will hardly cut all the roots, and if the season should be a moist one there will be a good deal of growth from roots that are cut off and turned under. This need not alarm the novice, for these plants will not make a vigorous growth in the succeeding crop and do no apparent harm.

The best crop to follow alfalfa is corn, beets or potatoes. Small grain is apt to lodge, though in a desert soil, as in Utah, where the writer once lived, grain had refused to grow at all until planted on alfalfa sod, when it yielded as high as sixty bushels per acre with irrigation. Likewise, in Colorado, it was thought that potatoes could not be profitably grown until some one tried them on alfalfa sod, when they became a staple and very profitable crop, whole train loads being sent from about Greeley to all parts of the land.

Corn on alfalfa sod will make a greater growth and larger yield than ever before seen on that soil, even in its virgin state. As the roots are large and tough and decay slowly, there will be a considerable remnant of the influence of the decaying alfalfa sod the second year, and it is the practice of the writer to sometimes take off two crops of corn in succession, manuring the ground for the second crop, and at once sow back to alfalfa, with a nurse crop of spring barley. This is good practice, for the reason that in the second year's manuring the weaker parts of the field may receive a double allowance of manure and thus the fertility of the whole be brought to a state of evenness.

It is notable that the second seeding of alfalfa on a field is more successful than the first, owing, no doubt, to the greater fertility of the soil, the ready inoculation with right bacteria and the better drainage owing to the decayed alfalfa roots which have thus made way for their successors. The third seeding has proven even better than the second on Woodland Farm.

It is foreseen that in a great wheat-producing region like Pennsylvania, where farm practices are so well-established and wheat growing has become a habit, that many farmers who become interested in alfalfa will desire to sow it with a wheat crop. The writer can give scant encouragement to this practice. Indeed, he has never seen an instance of success with alfalfa sown on winter wheat in the spring. The soil is not in condition for alfalfa seed and the crop seems to exhaust the soil of moisture to such a degree that the alfalfa dies in part, leaving a thin stand. This point has already been enlarged upon, but is of such vital importance in a scheme of rotation in which alfalfa enters that it is repeated.

#### A ROTATION WITH ALFALFA.

The writer finds a short rotation with alfalfa difficult, not because it takes too long to establish the alfalfa (it takes no longer than with red clover), but because it is so difficult to decide to break a profitable alfalfa sod. His ideal rotation, as practiced on Woodland Farm, is barley, sown with alfalfa, one year; alfalfa, four years; corn, two years; barley and alfalfa, again. This rotation gives too much alfalfa hay in proportion to grain grown upon the farm, but it has been found that, as a rule, the hay grown upon one acre would buy the corn grown upon two acres of his neighbors' farms. The expense of growing the acre of alfalfa and harvesting it was much less than of growing and harvesting an acre of corn.

## ALFALFA COMPETITION ELSEWHERE.

In the West, in wide, grassy regions, not infrequently the settler is alarmed by seeing in the distance clouds of smoke and at night a lurid sky, betokening a stretch of approaching prairie fire. His course, in defense, is to set, close to his own pastures, a back fire that will head off the approaching destruction.

Observing students of agricultural conditions have become alarmed by the rapid increase of production of meats, bread-stuffs and dairy products of the West. One of the chief factors of this cheap Western production is the alfalfa plant. By the aid of it and the cheap corn, the cost of producing a pound of beef, mutton, pork, cheese or butter has been cut in half, and at the same time the depletion of soils has been checked. Eastern agriculture has suffered, in consequence, and we find the anomalous condition of fine farms for sale at a cost less than what the buildings are worth. Eastern farmers, forsaking the production of beef, pork and mutton, with their accompanying piles of manures, take refuge in production of city milk, or try to compete with the West in butter production, meanwhile helping out the farm with artificial fertilizers and buying a large part of the protein fed to their cows. There is no sufficient reason for this state of things. Eastern farmers have sufficient advantage in their nearness to markets, in their general good roads, in their access to intelligent and faithful labor, so that they need not fear the West, but they should call to their aid all the resources which the Almighty has placed at their command.

There is a further menace from a land at the other end of the earth. Argentina is awakening to the fact that she can grow alfalfa and fatten cattle and sheep thereon. There is also, in Argentina, a great area of fine corn land and this is being rapidly developed, while both corn-fed and alfalfa-fed cattle are killed and sent in great ship loads to England. There are alfalfa ranches in Argentina of 60,000 acres extent, and the labor there being cheap and the soil extremely fertile, meat production is carried on at the lowest possible expense.

Considering, further, that the immense areas of wheat land in Siberia, Manchuria and the Canadian Northwest (besides those of Argentina, which are very extensive), it would seem that there may come a time when American farmers will be subject to a competition in the world's markets much more severe than any they have yet felt. It is well, therefore, for them to call to their aid every plant, every practice that will enable them to maintain the fertility of their soils and make them break out in bounteous crops with the least possible labor and expense.

It will, indeed, be a happy day for Pennsylvania when alfalfa

culture is thoroughly understood and generally adopted by her farmers. Then will the fields be covered with beauty, regardless of heat or floods or drought; then will the barns stand filled to bursting, the orderly stacks dot the fields, the cows well-fed, with full udders, the sheep and pigs fat and content; the villages even will feel the influence of the plant, for labor will be in greater demand, land values will advance, the boys stay on the farms, where they will be needed, and new evidences of prosperity will be seen on every hand.



COMMONWEALTH OF PENNSYLVANIA.

DEPARTMENT OF AGRICULTURE.

BULLETIN No. 129.

ALFALFA CULTURE IN HUMID LANDS,

BY

MR. JOSEPH E. WING,  
MECHANICSBURG, OHIO.



*PUBLISHED BY DIRECTION OF THE SECRETARY.*

---

1904.

---

WM. STANLEY RAY,  
STATE PRINTER OF PENNSYLVANIA,  
1904.

5000 total

b